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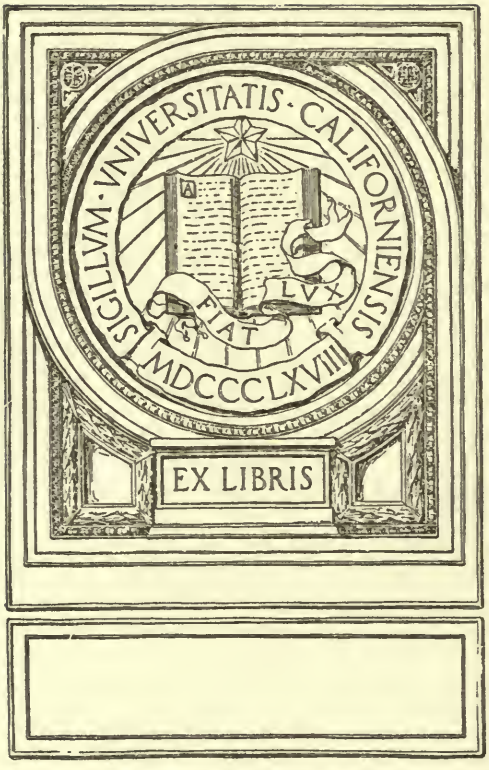
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THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING

ACADEMIC AND INDUSTRIAL EFFICIENCY

BULLETIN NUMBER FIVE

1910

UNIV. OF CALIFORNIA

ACADEMIC AND INDUSTRIAL EFFICIENCY

A REPORT TO
THE CARNEGIE FOUNDATION
FOR THE ADVANCEMENT OF TEACHING

BY
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MEMBER OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

BULLETIN NUMBER FIVE

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PREFACE

THE reason for such a study as is set forth in the present bulletin is found partly in the existence in the college of new and large problems and partly in the criticisms of American colleges and universities made during the past few years by business men. I believe that American men of education have faith in the future of the American college, and that they welcome any effort on the part of the business community or other intelligent men interested in education to better either the educational organization or the educational curriculum. This study is offered from the viewpoint of one outside college work who has to do in the main with the study of the efficiency of industrial establishments.

The administrative organization of American institutions of higher learning more nearly resembles business organizations than do those of most countries. The machinery of organization, with a president, a board of trustees, and a staff of deans and assistants, resembles closely the business organization of a corporation, with its president, its board of directors, and its heads of departments. One of the questions most frequently asked by foreigners concerning American institutions is, whether this organization, business-like at least in appearance, is consistent with academic freedom and elasticity, and whether it furnishes results comparable in efficiency with the large measure of authority vested in it.

One may distinguish roughly three different aspects of American university activity, in reference to each of which it will naturally be asked how far criticism from the standpoint of the present bulletin is pertinent. First, in so far as the American university handles money and deals with questions of effective organization and administration, any experience derived from the industrial world is distinctly applicable.

Second, there is apparently a realm to which the industrial point of view is obviously inapplicable. The manufacturer must know in terms of dollars and cents the actual cost of every step he takes and of every product he turns out; and even when he carries on some particular form of activity at a loss, it is on the basis of a calculation that he will create ultimately a market sufficiently large to convert the loss into final gain. In the upper regions of academic activity, namely, in the field of research, no such close or consistent correlation between work and expense is feasible. A certain degree of irresponsibility must be conceded to the investigator. He must be allowed to take large chances, if his judgment approve. The ultimate outcome of an expensive research may be slight, just as the ultimate outcome of an inexpensive research may be extremely precious or profitable. In general the extent to which a university may engage in investigation is undoubtedly to be determined

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in large measure by its business judgment, but given any particular sum which may without prejudice to prior duties be devoted to intensive investigation, it would be thenceforth unwise to attempt step by step to follow the industrial analogy closely. It would appear that once an institution is clear as to the sums it can devote to research, the business analogy may have very little application beyond that point. There is, then, one area within which the industrial organizer may have much to tell our college administrators. There is at the far end another within which he may achieve nothing.

The third aspect of education to which I referred lies between the two extremes. Here is an expansive territory to which conceptions of the nature of this bulletin have seldom been applied and within which it is open to discussion as to how far they are suggestive or helpful. The study which follows has been made by Mr. Morris Llewellyn Cooke, under the direction of the Carnegie Foundation. Mr. Cooke is one of a group of engineers who specialize in the organization and management of industrial establishments and the installation in them of improved methods based on a scientific study of the results desired and the processes involved. The value of the report, therefore, lies not only in the care with which it has been made, but also in the standpoint from which the investigator has considered college work. That standpoint is the same which Mr. Cooke takes when he examines a manufacturing concern.

It is not the purpose of the Foundation to present any criticism of this report or discussion of it. Its value to education lies in the presentation of the study from the standpoint which its author occupied.

However strongly one may insist that the college, as an intellectual, moral and social organism, must be viewed from a different standpoint than that of factory efficiency, it is still true that all large and continuing causes rest upon formal organization and upon some assumed machinery of administration. There are two sides to all administration, whether it be the administration of an army, of an industrial establishment, or of a college: the mechanical side and the human side.

The first concerns itself with the preparation of the machinery suitable to the work to be carried out. That machinery will vary according to the size and the nature of the enterprise. The organizations appropriate to an army, a bank, a factory, and a college differ, but each alike demands machinery suited to the work which it undertakes to do.

The human side of administration consists in getting out of the men who compose the machinery the most devoted service and coöperation of which they are capable.

Both of these ideas enter into every form of military, business and social organization. That organization is the most successful and most efficient which, having

planned clearly and wisely the machinery of its operations, develops also such leadership as to make the machine a living organization, each man in it contributing the best there is in him and coöperating with every other man.

I apprehend that these fundamental principles of organization and of administration are accepted by all. Furthermore, it will be generally admitted that in a few decades our colleges and universities have expanded enormously, and that they have undertaken, under new and hitherto unknown conditions, operations of far greater complexity than they dealt with during the previous quarter century. It may therefore well happen that the mechanical side of their organizations has not kept up with the demands and the complexities of their problems, and that they may gain from the intelligent study of college forms of organization a real help from those who conduct industrial enterprises, without at the same time in any measure losing sight of the fact that scholarly and spiritual leadership is the highest quality of college efficiency and the one most necessary to attain. It may be well also to remember that sincere and helpful leadership in intellectual and spiritual matters will in no wise be injured by a frank and open examination of the material factors which enter into college problems.

There is a still more practical side which has as yet received but scant attention, but which must in the next decade be met squarely by those who direct educational institutions. The cost of university education has risen throughout the world, but nowhere so rapidly as in the United States. Single universities in America are now spending larger incomes than any educational institution has ever spent in the world's history. Not only is this true, but the whole demand of the American university to-day is for more money. No doubt this demand is urgent; nevertheless it is clear that this process cannot be indefinitely extended unless we greatly restrict the number of universities. It may well be that a thoroughgoing administrative study of the income and expenditure of one of our large and newly grown universities may be more helpful to it at this moment than more money. We have gone through a period of great expansion. Just now a critical examination and appreciation of what we are getting out of the expansion is probably more to be desired than farther expansion.

In any event, only good can come to an organization—whether it be commercial, educational, or religious—when a friendly hand turns the light of public scrutiny upon its methods, resources and aims. This study is therefore commended, without discussion as to its merits, to the thoughtful examination of college officers, trustees and teachers, as a friendly attempt to contribute to the solution of college problems from the standpoint of one who has to do with industrial efficiency, and without any preconceived opinion as to how far the analogy which its title suggests

may be pushed. The college is partly a business, and partly something very different from a business. Mr. Cooke is concerned only with the former aspect. It will be interesting for those to whom the latter viewpoint is more natural to consider how far his observations have suggestive significance.

HENRY S. PRITCHETT.

October 7, 1910.

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PART 1

UNIV. OF CALIFORNIA

INTRODUCTION

IN the instructions calling for this report it was stated that the object was to obtain an estimate of the cost and of the output both in teaching and in research in the departments of physics in the following institutions:

Columbia University,
Harvard University,
Massachusetts Institute of Technology,
University of Toronto,
University of Wisconsin and
Haverford College.

Two institutions were added later to the list:

Princeton University and
Williams College.

It was suggested that, in visiting these institutions with the main object of securing the data upon which this study could be based, the writer avail himself of the opportunity for noting any features of the life at these institutions or their practices which would throw light on the general problem of their work and administration.

In his verbal instructions to the writer, Dr. Pritchett stated that an educator could not be utilized for the purpose of making this report, because the Foundation wanted especially to see the institutions to be visited through the eyes of a business man, and of one generally familiar with modern practice in management. So that if in this report terms are used which are more frequently encountered in the industrial world than in our colleges and universities, it is because it has seemed best for present purposes to minimize the differences which exist between the two classes of institutions, rather than to point out the places where they are essentially different. In studying the various operating mechanisms used by the colleges the writer has had constantly before him for purposes of comparison the equivalent mechanism used in the industrial world.

It may be interesting to state why the department of physics was chosen. This was for three reasons: first, because it was believed that physics, considered as an integral branch of collegiate and university education, is taught as efficiently as any other; second, it includes lecture hall, laboratory and recitation room work; and third, because owing to the fact that it is a comparatively modern subject, it has accumulated less "moss" than perhaps attaches to some of the subjects which have been a regular part of the curriculum for centuries.

These explanatory remarks are given so that it may be understood that the purpose of this inquiry did not include any special interest in physics which was not felt for other subjects of teaching. The interest in physics is, therefore, more or less accidental, and the study of it must be looked upon as a specimen, which might

have been duplicated, to a considerable extent at least, in any one of the other departments. It will be admitted that, if a system of management can be developed under which the efficiency of any one department can be measured, the same scheme, more or less modified, can probably be applied to other departments, and that the result of applying it to all departments will in large measure gauge the ultimate efficiency of the entire university or college organization.

In this report, while the writer has had quality constantly before him, he has been forced to confine his observations very largely to questions of quantity. But the effort has been to make quality a background for everything that may appear to have only a quantitative value.

It will not be amiss to call attention at the outset to the fact that it is comparatively easy to make a formidable criticism of the best organized industrial undertaking. The more conversant with matters of management one becomes, the more one will realize how far from ideal, judged by any of the best standards, are the conditions which obtain in any part of our industrial world. In fact, the beginning of the study of management as a science dates only a few years back, and there are even now relatively few in the industrial world who look upon it as a subject in which the problems are capable of a scientific solution.

There is a great difference in the matter of management between different lines of industrialism. One industry may have been forced to a high degree of efficiency through intense competition, or through some more or less accidental cause; while another, managed by men as able, may be using the methods of a generation past, simply because it has never felt the spur of necessity. In making a study, therefore, of the colleges and universities, one would expect to find much that could be improved. And it also follows that in attempting to reach a conclusion on the value of the work done to date by the men responsible for the organization of our institutions for higher education, one must in fairness to them have in mind the *average* efficiency of management outside of the colleges *as well as* the more conspicuous examples of administrative efficiency.

As a result of a relatively large number of interviews with persons connected with the institutions visited, I am convinced that many are expecting marked changes in method to be brought about within a short time, and that in most places these changes will be welcomed. In the writer's opinion, the greatest progress will be made in effecting needed changes in collegiate and university methods, if it can be done without the accompaniment of extreme criticism and the ordinary methods of attack. The colleges and universities are not dreading change, but they do dread the strife by which some seek to bring it about.

There is undoubtedly, too, some feeling on the part of most college professors that changes brought about at the hands of business men may be made without sufficient respect or regard for the verdict of time. Undoubtedly business men as a class do think in short cycles. If a certain modification in business methods will bring

better results in the next ten years, it will be made without much regard to what follows. On the other hand, it is one of the functions of a university to stand for what has proven to be good practice over longer periods of time, or for that which gives promise of such proof.

In going about, the effort was made to get at the viewpoint of all the different grades of teachers. In some institutions I talked with nearly all the members of the teaching staff of the department of physics. But of course for the most part the interviews were with those in charge of the institutions and those in charge of the physics departments. This word of caution is introduced here because I know that in many matters of collegiate administration the policy of the so-called "heads" is opposed more or less by their assistants.

There are of course many phases of the problem of the colleges which purposely are not touched in any way in this study, such as, for instance, the relative merits of the different methods of teaching. The effort has been to confine the observations to those features of college and university work which are affected by business considerations. A large part of the field is therefore not treated in any way.

It is usual in the industrial world to find manufacturers and business men who look upon their own undertakings as being essentially different from every other seemingly like undertaking. This could not be otherwise, because every one knows the difficulties of his own work better than those of his neighbor. So I was not surprised to learn that every college feels that it has problems unlike, and of greater difficulty of solution than, those to be encountered at other colleges. As a matter of fact, from the standpoint of organization, uniformity in collegiate management is a much easier problem than it is in most industries, because in any industry which I know about, the individual plants vary considerably more than do the colleges.

Every effort has been made to present accurately conditions as they are. The character and breadth of the study are such as frequently to have prevented my going into a given situation as minutely as under other circumstances might have been desirable. If at any point I have not reflected what it was sought to convey to me, I regret it sincerely. It would probably be impossible to find a group of men more willing to let one know the full measure of their ideals and of their work than are the men of the universities.

Without exception, everyone seemed anxious to answer my questions fully and fairly, and everywhere the liveliest interest was shown in the possible fruits of the inquiry. There was not even the suggestion anywhere of a desire to have me secure less than the full measure of what I sought. This enthusiastic coöperation received at the hands of everyone made of work a pleasure and is largely responsible for such value as may attach to the result.

GENERAL OBSERVATIONS

It is impossible to avoid the conclusion, after even a casual survey of this field, that the men connected with the colleges and universities have looked upon their functions as having very little in common with those which engage the attention of people in other walks of life; and any one making such a study as this is first of all impressed with the price that is being paid to maintain this position of isolation. This one element of the problem would be enough to account for the growth of most of the things which, in my opinion, may profitably be changed.

The impression gathered was that if, in the past, the teachers at the colleges may have fought the coming in of the outside world, they have now either changed their position as a class or are about to change it. It is certainly true that a great majority of individuals interviewed seemed anxious to gain any assistance that could be given them.

Perhaps the most notable feature of collegiate administration is the entire absence of uniformity or accepted standardization. As the question of standards and standardization necessarily has an important place in management, opportunity must be taken to point out what the terms mean when used in this report. A standard under modern scientific management is simply a carefully thought out method of performing a function, or carefully drawn specifications covering an implement or some article of stores or of product. The idea of perfection is not involved in standardization. The standard method of doing anything is simply the best method that can be devised at the time the standard is drawn. Standard specifications for materials simply cover all the points of possible variation which it is possible to cover at the time the specifications are drawn. Improvements in standards are wanted and adopted whenever and wherever they are found. There is absolutely nothing in standardization to preclude innovation. But to protect standards from changes which are not in the direction of improvement, certain safeguards are erected. These safeguards protect standards from change for the sake of change. All that is demanded under modern scientific management is that a proposed change in a standard must be scrutinized as carefully as the standard was scrutinized prior to its adoption; and further that this work be done by experts as competent to do it as were those who originally framed the standard. Standards adopted and protected in this way produce the best that is known at any one time. Standardization practiced in this way is a constant invitation to experimentation and improvement.

It is practically impossible to find any one broad problem of university government solved in the same way by two institutions. This lack of standard methods is particularly marked in the financial administration of colleges. Thus, in the matter of inventorying lands and buildings Dr. Eliot, then President of Harvard University, said: "We try to come as near forgetting the value of our lands and buildings as possible. This makes the simplest bookkeeping." At the University of Toronto

all lands and buildings were held at values recognized as having no real significance; and the board of trustees was to meet in the near future to decide as to whether the whole plant would be "inventoried at a dollar, or present values assigned to each item." At the University of Wisconsin the most recent methods of inventorying and of valuing everything going to make up the plant were in use.

As further on in this report instances of the same absence of uniformity will be given to illustrate other points, nothing will be gained by multiplying examples here. It must be considered remarkable that, in any line of endeavor which has been continuously followed by educated and specially trained men for several hundred years, almost nothing has been so systematized and staked down that it has ceased to be now almost a day-to-day matter for discussion. In most lines of business, for instance, there are certain printed forms used by practically every concern in the same line. Business practices have so crystallized that the methods of two concerns at remote points will be in many cases almost identical.

As a result of this inquiry, the writer is convinced that there are very few, if any, of the broader principles of management which obtain generally in the industrial and commercial world which are not, more or less, applicable in the college field, and as far as was discovered, no one of them is now generally observed. At nearly every institution progress has been made along certain lines, but generally it has been a "lone fight;" one institution doing one thing and another doing another, without any of the mutual help and coöperation which is given in the business world. Indeed, it is not going beyond the facts to say that in the college world there is less real cooperation than one finds in those industries where competition is the most intense. The colleges are not only not organized for the exchange of help and information and data, but as a rule it appears that they do not care to afford it. The broad reason for this difficulty seems to be that the records of the colleges as a whole, and of the individual departments, are inadequate, and are so lacking in uniformity that any effort on the part of one college to help another is made with too much difficulty.

Lack of Intensiveness

As accounting to a great degree for the absence of gauges, there may be noted the general lack of intensiveness which one finds everywhere pervading the universities and colleges. Without expressing an opinion as to how much of this lack of intensity is a necessary or desirable part of life at these institutions, no adequate relief can be obtained for many generally acknowledged faults without taking it into consideration. Let it be admitted that a certain amount of tranquillity is an absolute essential in one or more departments of academic life. It will be admitted that with such tranquillity a factor in even one department it must necessarily more or less affect all the others. But because it is recognized as a vital element in one part of the work, it is not necessarily of advantage everywhere. It may be an absolute hindrance in some departments. The more necessary to efficiency this deliberative method be-

comes in any one department, the more necessary it becomes to study it and recognize it as an essential factor in university life. A concrete example of this is found in the length of the working day. It is almost invariably the case that the hours observed by the accounting departments and by the janitors and gardeners bear a direct relation to the hours of the teaching staff or of the student body. This may be an inheritance from the old days when everyone associated with a university had some organic connection with it; when even the farrier and the cook wore clothing betokening their scholastic affiliations, attended church services, and performed other duties after a manner which made it necessary that one schedule should be observed by all. Is it good practice to close practically all lines of activity at Princeton University on a Wednesday afternoon because there is to be an athletic contest attended by a considerable part of the college community? It hardly seems advisable to have the gardeners begin their day at nine simply because recitations begin at that hour, and especially when it is probable that the gardeners would be more efficient if they began work earlier.

At only two or three of the institutions visited did it seem to me that the work of the accounting departments was done under conditions at all comparable with what goes on in the every-day business world. And only at Columbia was there anything to impress me with the snap and vigor of the business administration. I could not see that in the case of Columbia the excellent organization indicated by the capable manner in which I was passed about from department to department, for instance, could have had any bad effect upon the educational efficiency of the place. Everywhere I went I seemed to be expected and the general tenor of my mission understood. I was promptly told what part of the data I sought would be immediately forthcoming, and on what date I would receive the balance. In the various clerical positions I found competent people fully engaged doing work along the best modern lines and splendidly enthusiastic about their institution.

In bringing these general observations to a close, it may be suggested that the first university which will try conscientiously to obtain all the help which it is possible for it to obtain from the commercial and industrial world in a broad effort to increase its effectiveness will make a very strong plea to men of means who have money which they are willing to devote to educational purposes. Every one likes to feel that the money which he devotes to educational and charitable and philanthropic purposes is well expended; and other things being equal, that university or that department within a university, which has an organization making possible the highest efficiency will in the long run receive the greatest consideration from such public benefactors.

GENERAL TYPE OF ORGANIZATION

As may be imagined, many different types of organization were found. On the one hand, several notable examples of the military or so-called one-man management were encountered; but committee management, sometimes in an extreme form, was more prevalent. Committee management seems to be the typical scheme under which our colleges are administered. Curiously enough—but nevertheless quite in harmony with the general lack of uniformity—at some institutions the military system and the committee system exist side by side. At some places, one man was virtually in control of the institution as a whole, while the departments were administered by committees. At other places, committees of the faculty or the trustees actually operated the school as a whole, while they turned over the affairs of at least some of the departments to designated heads. Taken in a very broad sense, I should say that an effort was noticeable everywhere to make the administration of the individual departments harmonize with the administration obtaining for the whole institution. At Princeton University the attempt to make committee management the type of both departmental and university control is eminently successful.

The opportunities for observing the methods of government were necessarily largely confined to the departmental organization as it obtained in the several departments of physics. There is reason to believe, however, that each form of departmental organization finds its prototype in university organization.

Of the military type, one instance was found of what might be called the "old school," where the department was administered almost entirely by one man having the title of director of the laboratory. While he was undoubtedly a distinguished physicist, his absolute—and as far as I could see unquestioned—control of his department seemed to result from the fact that he was both in point of age and in years of service the senior of all his associates. While there were evidences of the opportunity for day-to-day conferences between different members of the department, the larger questions of policy appeared to be decided absolutely by the head of the department. The latter undoubtedly sought the views of the other teachers, but I am of the opinion that he did not feel that their views should necessarily find expression when they did not coincide with his own. This man in large measure controls the advances in salary of his associates. Many evidences were to be found that this policy was giving results. I am not either praising or condemning it, but simply trying to describe a distinct type which I believe was formerly prevalent in the colleges and which is now becoming rare.

At the University of Toronto the head of the department had been assigned to his duties, with the title of director of the laboratory, by the head of the university; this, as I was informed, after consultation with the board of trustees and other members of the faculty. He had been selected for this place chiefly on account of his administrative ability, although his pedagogical and scientific attainments were also of a

high order. He decided every question that came up in the department, sometimes after conference with those members of his staff whom he considered most competent to give advice. He stated definitely that he never "deferred" to his associates. What are generally supposed to be the dangers and drawbacks of one-man management having been pointed out to him, he said that he thought there was nothing in them, that when he had lost his efficiency as an administrator he expected the president of the university to supplant him, and that he would take his position in the ranks of the teaching force, or even leave the service of the university, without resentment or without feeling that his days of usefulness were necessarily over. The results which this man showed in his work certainly afforded the strongest possible argument that can be made for the extreme of military control in an educational department.

Two notable instances of committee management were found at Harvard and Princeton. Perhaps the most remarkable feature of each of them was the solidarity of the staff. In the case of Harvard it was almost impossible to discover any difference of opinion in the matters of management between the various members of the staff; and in the case of Princeton such differences of opinion as were entertained were held in such respectful deference to the opinions of the others that good rather than harm seemed to come from this condition. This good feeling in connection with committee management at these two institutions is pointed out for the reason that in the industrial world such harmony would hardly be expected, and in fact it is not always desired. It is held by some that the strong point of so-called committee management is that there will be a division on almost any question that comes up, and that therefore while both sides will get a hearing, each position will at the same time be subject to attack.

At Harvard there was rotation in the performance of the various functions connected with the work of the department. This rotation was controlled by the departmental staff. It was in a measure theoretical because the post of director of the laboratory did not seem to be one subject to rotation. Everybody said that the present director was so efficient that the committee managing the department never considered any change in his duties. As a matter of fact this is simply one place in the management where it seems to be military and not by committee.

The men of the universities are apt to feel that, their training and ideals being what they are, it is possible for them to "get along" with each other with less friction, and even less liability thereto, than one would expect to find outside university walls. I think they will discover that there is little in this. When university life and university organization become as closely interwoven and as intensive as there is now every promise of their becoming, university men will have to erect the same safeguards against certain phases of individualism as are found necessary in the outside world.

But if we can study the effect of committee management at two institutions where such harmony prevails, it might seem that we are studying it at its best. At

Princeton, one of the places where this ideal condition of committee management obtained, the principal argument for it seemed to be that it was *democratic*, and the writer was asked how it would be possible to get high-class professors if they had to work under some one else. The general committee in charge of the department worked largely through sub-committees on shop, general expenses, laboratory, lecture appropriations, laboratory appropriations, research appropriations, etc. It was stated by some members of the staff that they could see no possible fault with the way the scheme worked. Others had their doubts as to whether the scheme would not work better if certain committees were supplanted by a single individual. Thus, it was suggested to the writer that the shop committee would probably get more work out of the shop if it was reduced to one man. Here was an extreme example of this kind of democracy because the sub-committee on shop consisted of three men, who directed one mechanician and his assistant. It was admitted that none of the professors who constituted this committee on shop, and in fact none of the men on the staff, was in any way specially qualified to run a shop. The work of these sub-committees, with the possible exception of that on shop, consisted largely in apportioning appropriations. The department, acting as committee of the whole, decided the assignments to work in the class-rooms and laboratories. As far as the writer could discover, most of this work was done on the outside by more or less informal conferences on the part of the ranking members of the staff. Certain members of the staff would get together, with a certain other member not included, and decide that he was to do research work. Other members of the staff would get together and decide that a certain other member, not being a good disciplinarian, should be given no lecturing, but should be given the smaller sections to teach, and so forth. Everyone of course was fully cognizant of this arrangement. As to the wisdom of this line of procedure there seemed to be the utmost harmony and unanimity of opinion. I think it will be admitted that such an arrangement as this finds no parallel in the business world. Where committee management is used, it is generally only advisory in its character, and where it is in force, the questions that are discussed are such as can be thrashed out in open meeting.

At the University of Wisconsin, where committee management was supposed to be in force, the writer found that as a matter of fact the department was being operated virtually by two heads: one in charge of the elementary work, and the other in charge of the advanced and research work. The informal conferences between the different members of the staff on matters affecting the department cannot be considered the equivalent of committee management. The university authorities were surprised to find out that no departmental meetings devoted to administrative matters were being held.

An extreme case of committee management in the general administration of a university was found at Princeton, where about one hundred and twenty men sit in the faculty. The faculty sitting as a whole and through its committees decides large

and small questions. The writer found that, as a rule, only fifty per cent of the members attend faculty meetings, but that when certain questions of general interest are scheduled to come up nearly everybody is apt to be present. At this same institution the trustees and especially the various committees of the trustees take an active hand in the details of administration. While I was visiting this university, the question was being debated as to whether the prices at which the outgoing class was disposing of its furniture to the incoming class were exorbitant or not. Action was suspended for two weeks pending a meeting of the trustees' committee on buildings and grounds. One of the higher officials of the university told me that the question in one phase or another had been a burning one since he had been an officer, which, if I remember rightly, had been for nearly twenty-five years. There did not seem to be any more to the matter than there is to any one of a dozen questions such as are decided by a good executive in a few moments after all the facts have been carefully gathered and codified. I am confident that either President Wilson or Dean Fine could have decided the matter in a way that would not have allowed it to come up again, but the custom of the place probably restrained them from doing so.

At the University of Wisconsin, the executive committee of the Board of Regents (as well as the head of the department, the dean, the president and the secretary) approve every requisition for the purchase of supplies. In some cases these requisitions amount to a few dollars, and in only few cases do they amount to more than one thousand dollars. It has been some time since the board of directors of any properly organized industrial establishment has done detail work of this kind. The thought was expressed that the approval of requisitions was synonymous with passing a budget. The two things are obviously distinct.

To the extent that the industrial analogy is valid, committee management seems to be, broadly speaking, very largely responsible for what appear to me to be the two fundamental weaknesses of the government of these institutions: first, that the departments have too much autonomy; and, second, that the heads of the institutions and of the various departments lack the essentials of real authority. I shall discuss these points briefly from my point of view, leaving it to educators to decide how far criticism of this nature is pertinent.

In the matter of the departments having too much autonomy, it can be said in a general way that, given the money to support it, a department is usually practically self-governing. In other words, the typical department very largely controls its own affairs, operates and maintains its own building, disciplines its students, arranges for the work of its teaching staff, and provides the courses of instruction. At some places one or more of these functions may be performed by the university as a whole for each of its departments. An example of this is the more or less recent development of the department of the superintendent of grounds and buildings. At Columbia for instance, this department practically controls the heating, venti-

lating, repairing, lighting and cleaning of buildings. Elsewhere other functions may be performed for each and all of the departments by the university itself, but these are, at the present time, exceptions, and the typical department is as above described. In industrial and commercial undertakings this degree of independence in general matters on the part of the department would be unthinkable. On the other hand, in matters which are peculiarly its own, the independence of an industrial department transcends anything which the universities know.

This departmental autonomy is, in my opinion, at the bottom of several conditions at the universities which call for some modification. There is no doubt, for instance, that the departmental organizations have forced viewpoints and lines of action on the part of the president and board of trustees which are essentially wrong, but which have been assumed in good faith in order to cope with conditions as they exist. The great bulk of the recommendations in this report cannot be put into efficient effect until departmental lines as they are generally in operation to-day are abandoned.

The autonomy of the departments has led to the absence of much real solidarity in our colleges and universities. One gets the idea from the solidarity which is apparent when it comes to athletics that this same spirit pervades all phases of the work. Unfortunately this is not true. Departmental solidarity there is, but it is being maintained very largely at the expense of the solidarity of the institution as a whole. One does not begin to find the coöperation between departments of a university which is expected of the departments of an industrial enterprise, and even in industrial concerns it is rarely as effective as it should be.

The lack in these institutions of effective authority on the part of the head men —the head of the institution as a whole and the heads of the various departments —is shown by the fact that the writer had his attention called to a number of abuses, pretty generally recognized as such, but which, having gone on for years, were still continuing without any sign of abatement.

In discussing the best form of organization for an institution of higher education, full weight must be given to the fact that most of the teachers are men of rare ability who have devoted years to training themselves in a special branch of knowledge. It then becomes, with most of them, a matter of the greatest importance that they should be able to devote every possible minute of their valuable time to the use of this knowledge and training.

The first great object of organization in the art of management is to make each individual in the whole body count for his maximum. A small amount of thought will show that this can be done only when each man does those things for which he is best suited. This leads directly to the reference of most questions up for settlement to the best single expert, or perhaps to the best two experts, obtainable for decision. In a committee this can never be done. Almost invariably under committee management there is the spectacle of three or more men, experts in their

own specialties, all simultaneously wasting precious time in deciding questions outside of their own field, which could be better and far more quickly decided by a single expert whose time may be worth less than that of any one of the three or six men on the committee. Modern industrial management seeks to relieve the head men of all possible routine such as is the great bulk of committee work, and so enables them to give their entire time to progress. At the same time these heads are kept constantly informed, through carefully prepared and summarized reports, as to all matters affecting the institution or its departments.

This attitude toward experts and expert opinions in the management of colleges and universities, one would expect to find heartily indorsed by college men. Dr. Eliot has expressed the same idea in another connection when he said: "To produce such experts and to instil respect for expert judgment is one of the most urgent duties of the American university. For insufficient appreciation of the value of expert labor is one of the worst afflictions of American life."

Management by experts suffers from the fact that too often in the past experts have not only held themselves aloof, but held their opinions to be above lay criticism or comment. Functional management seems to guard against this by providing that all standards shall be written out and thus clearly understood by everyone; that they shall be capable of scientific demonstration rather than the result of personal opinion; and that they shall be at all times subject to scientific re-examination and analysis. In this way only can expert judgments be given the benefit of the corrective influence of lay minds.

The writer believes that genuine committee management invariably involves lack of initiative, division of responsibility, and log-rolling. One group who stand for a certain idea will gather to their support individuals who are perhaps only indirectly interested in the matter under debate, but whose advocacy can be secured in return for support for some other idea in which they happen to be interested. There are any number of questions which are being constantly debated at the colleges that are kept alive only by this ability to line up the entire institution on either one side or the other of the question, through committee management. Only a small percentage of such questions would appear to have any real educational significance.

Committee management generally means compromises reached by discussions, and compromises frequently leave something to be thrashed over at a later date. In management what is wanted is decisive action and the ground covered in such a way that as little as possible will have to be covered again. In how far this procedure, indispensable in business, is applicable to college administration I am not prepared to say.

Perhaps it is because of the fact that our colleges and universities have from time immemorial been organized more on the committee basis than on the military basis, that they have as a class adapted themselves less promptly to changing conditions than have most other human institutions. The fact that any given number of indi-

viduals connected with a university teach advanced ideas does not mean that acting collectively they will take advanced ground in matters of management. In fact, it seems to work the other way. At those schools where there were the largest number of "big men" I found what seemed to me to be least desirable systems of management.

After having seen both the military type of management and committee management, apparently each at its best, the writer is convinced that, in the educational world as in the industrial world, neither of them will give the best results. The way out lies through functional management, where the effort is made constantly to have each man perform those functions which he is best fitted to perform, and to prohibit him from interfering in the performance of those functions about which he is not specially qualified to give an opinion.

Perhaps the chief object in functional management is to safeguard a man in the performance of the highest kind of work he is competent to perform. This is in large measure brought about by relieving him of those duties which can be performed as well, or almost as well, by some one whose time is not so valuable. The college professor is specially qualified to do some things which nobody else can do as well. Functional management will seek to protect him in the performance of these duties and relieve him of the things which can be performed by other agencies.

Under functional management the individual at the head of an institution will have more power, and less power, than at present. He will be more hemmed in by standards, but in those matters not covered by standards he will have more latitude and real authority. In fact, it would seem that the head of a great university should remain at his post only so long as his methods inspire confidence in his board of trustees. It is impossible to conceive of the president of a steel works, for instance, making any progress if he were to be constantly thwarted and kept from deciding things by his board of directors. Yet this is the rule in the college world. In matters of simplest routine, such as in many industrial establishments are decided by clerks, the board of trustees expects the president to wait until he has ascertained its wishes—usually as expressed by one of its committees. Dr. Frederick W. Taylor, in lecturing on this relation before the Harvard School of Business Administration recently, said:

"The proper functions of the board of directors would be, for instance, to select, after having proper evidence presented to it, the broad and general type of management to be introduced in the establishment.... After having done this, and after having broadly stated the policy of the company, as to payment of wages and salaries, they should not mess into the detail of the personnel—by ordering the president to employ this man, or discharge that man, or promote another man. Nor should they vote a reduction of wages or an increase of wages contrary to the leadership of their president.

"Other functions of the board of directors should be, for example, dictating the broad policy to be followed in the sales department; namely, whether the sales are to be mainly conducted through agencies or travelling salesmen, and the extent and

kind of advertising to be used. Again, however, the *details* of the executive work should be left under the direction of the president. The general financial policy of the company should also be one of the functions of the board of directors, as well as the broad lines along which progress is to be made. That is, the decision as to the type of new product to be manufactured and sold, and the volume of business which is to be prepared for.

"The president should lead his board of directors rather than be a tool to be guided by them in detail; and when it becomes impossible for the president to lead in the carrying out of the general policy of the board, another man should be selected for the head of the business who is in harmony with the board's wishes and competent to lead them.

"The world's experience in all directions has demonstrated the utter impracticability of doing successfully executive work under the management of a body of men either large or small. An executive committee of *one* is the best committee to have in charge of executive work. The president should be free to have as many advisers around him as he wants and these men can be called an executive committee as well as by any other name; but their duties should be those of advisers. In all executive acts they should be under the orders of the president and they should not be allowed to control his acts by a majority vote. He should in principle occupy the same position as the President of the United States. He should be free, practically, to select his own cabinet, and then should be in complete command of these men. The men under him should be free to advise him in the most emphatic manner, but the final decision in all matters should rest with him, and the board of directors should not entertain nor act upon appeals made to them from the cabinet officers beneath the president."

Functional management takes the position that even in a partnership of two men the best results will be brought about by assigning to the one partner the final authority in one class of questions, say manufacturing, and to the other the final authority in another class, say selling. In this way the final authority in every branch of the business will be left to one man, and the effort of course will be to have the division so made that such questions as come up will be decided by the partner who is best qualified to render the decision. There is nothing in this functional arrangement to make mistakes impossible, but it can be demonstrated that, in the long run, more progress will be made than when it is necessary to get everything passed on and approved by two men, and furthermore the general average of the work will be better.

Or, put another way, functional management says that with A and B launched on an enterprise three arrangements are possible: (1) A can work altogether under B's directions; or (2) B can work altogether under A's directions; or (3) the work can be so divided that A will work under B's directions in some things and B will work under A's directions in the balance. But under modern scientific management they cannot work *together* in anything and do it efficiently.

Applied to the work of the colleges, this functional method then will mean that

the work of any given institution will be divided into ten or one hundred functions, and that in each of these functions some one person must be supreme. Such a functional foreman or manager may have any number of advisers, but he may or may not act on such advice as is given him, exactly as he sees fit.

Attention must here be called to the difference between (1) dividing all the work of a given undertaking up between a certain number of positions, the occupant of each such position having many functions to perform, and (2) dividing all the work up into a certain number of functions with some one person supreme in each such function. Under this last arrangement it is possible to have experts pass on every question that comes up for settlement. Under such a system of functional management one cannot afford to sacrifice expert advice by allowing it to be upset by inexpert individuals or committees higher up or lower down.

The difference between this functional system and the familiar military or "one-man" system will be apparent. Under the military plan, a man can work for only one master, all his orders come from one man, and, theoretically at least, they all come from the top. The top man has the right to pass on everything and to issue orders about anything to anybody. He simply sees to it—if a general, for instance—that he passes such orders down through his colonels, majors, captains, *et al.*, until they reach the particular individual affected. Therefore, while any one man receives orders *through* only one man, he is subject to the orders of everybody who ranks him. Under functional management any one individual may receive his instructions from as many different people as there are functions which he performs. But, theoretically, he never gets any instructions from those who are not experts. Under this system one's work is not constantly being upset by those who in reality know little or nothing about it.

Functional management is based on the belief that there is one best way to do any one thing, and that usually this best way can be determined by scientific methods if people will use them. Under functional management every effort is made to discourage the practice of deciding matters—big or little—on anyone's personal opinion. The attempt is made to limit the field wherein arbitrary decisions control action. This means for everyone connected with the universities a more sharply defined function, and I do not think from the talks I had that any change will be more welcome. In the last field where you would expect to find it, one encounters perhaps the extreme of unwarranted interference. A professor will frequently have to conduct a long fight—and in the end an unsuccessful fight—to maintain an obviously correct position because a committee of the trustees which has but a modicum of information upon a given situation, and no special aptitude for discussing it, has the power to interfere and does interfere.

The dean of one college, who had recently attended a gathering of the "administrative" officers of the colleges in his immediate vicinity, told me that on comparing notes with those he met, he found that he was the only dean who had any real

authority, and that most of those with whom he talked did not know how much they were supposed to have. As will be pointed out more in detail later, most discipline is meted out with the full understanding that it may be upset by some one higher in authority. In almost every case discipline, even of a minor order, is subject to revision.

At Princeton, while as a matter of practice the departments were allowed to attend to the details—and only occasionally were they upset—the most unintelligent counsel prevailed at times on matters of real moment. In other words, there were no bounds to the authority of those "higher up" when they cared to use it. One or two committees of the board of trustees had the power to enter almost every nook and corner of the educational structure. This inspection of course would be all right—excellent—if it were made for the purpose of seeing that the general policies were being carried out; but too frequently there is no permanent general policy and these acts are the promptings of personal whims or prejudices. Everyone from the president down told me that committee management was adopted because it was a democratic form of government. The result struck me as being a far cry from real democracy.

NO PRESENT GAUGE TO EFFICIENCY

One is struck in any such study of collegiate conditions with the absence of any gauge of efficiency which even remotely resembles, for instance, profits in an industrial undertaking. Anyone investing money in a business may with some reason be rather care-free as to the manner in which that business is administered, because at the end of any given period he has an opportunity of judging the management by the profits earned on his investment. In the same way, a man who is at the head of a business can devote much or little time to the supervision of any one department with the thought that at a given date the books will be closed and the management of that department will be fairly accurately reflected in the excess of receipts over costs. One looks in vain for anything analogous to this in education, and after the larger question of the type of management has been determined, perhaps next in importance is to get some gauge or measure which can be used as a means of comparing the work of one department with another inside of the same institution; and the work of similar departments in two institutions, and in fact of one institution as a whole with the work of another. Any such basis of comparison that might be adopted now would probably have to be, at least in a measure, modified, as college administration develops, but before any progress is possible some selection must be made, and the writer wishes to suggest as perhaps the most immediately available unit the student-hour.

By a student-hour is meant one hour of lectures, of laboratory work, or recitation-room work, for a single pupil. Thus, a section of thirty students on a three hours' laboratory period would mean ninety student-hours. A section of ten pupils in a one-hour recitation would mean ten student-hours. This seems to afford a unit which can be used for a great many different purposes. With this as a basis, we can get some tally on the efficiency with which the buildings are operated, the cost of undergraduate teaching, and each of several other items which go to make up the expenses of a university. Little or no value will attach to the student-hour as a means of gauging the cost of research teaching. It is believed that the student-hour will be found to be a valuable gauge for collegiate effort even where cost is not involved. The use of the student-hour will be further developed under the head of financial administration.

Without question, after the student-hour has been used for a period, various methods will suggest themselves whereby it can be made more serviceable as a unit, or other units better adapted to the purpose will be proposed.

The student-hour can be used in some places by weighting it, where otherwise it would have little value. Thus, in discussions of what should constitute a term's work for a teacher, one lecture hour would probably count as the equivalent of two or three laboratory hours. The adoption of some unit, even though it is not any more generally satisfactory than the student-hour, will quickly lead to many standards

now much needed. I was able to discover, for instance, no very generally accepted relation between the arduousness of laboratory, lecture-room and recitation-room work, either for pupil or instructor. It would seem that some working rule in this matter would be almost necessary in apportioning work between the various teachers in a department.

In judging costs especially, it will be necessary to take into consideration the different grades of student-hours. Thus, elementary work will always cost less than the more advanced principally because of the relatively larger sections. A school having a large number of graduate students would, other things being equal, of course show higher student-hour costs.

It was suggested above that in judging the value of research by its cost the utmost caution should be used. The same kind of caution and the nicest judgment will be required in noting the relative costs of student-hours in different branches. There will be some branches doubtless in which the cost per student-hour will be practically the same. But there will also be some branches in which the cost per student-hour will be high as compared with the average. It should be borne in mind that the cost per student-hour has absolutely no value in distinguishing relative educational values. It is only to show what the cost is in each branch. With this cost known, it will be much easier to decide whether or not a given school is warranted in continuing a given branch.

The great advantage of the student-hour is that it is small enough to get inside of all the various combinations of courses, schools, departments, etc. The student-hour will be as full of meaning when it is used for keeping costs of a college of engineering including any number of departments or courses, as it will be in keeping the cost of a single lecture course.

THE COLLEGE TEACHER AS A PRODUCER

In all professions experience shows that important changes come from within. College professors particularly have felt that their profession constituted them a class separate and distinct from other occupations and that improvements must be home-bred. But to-day, teachers, doctors and lawyers are all showing an increasing tendency to go afield in the search for implements and methods, and while such changes as are made in the college world will in the main have to be made by or through the professors themselves, it will be a gain if the professors will more willingly seek to profit by suggestions derived from the world outside.

An alert manufacturer is constantly engaged in trying to find out not only what his competitors in his own line are doing, but he is constantly sending into other industries to see what may be found in them that is applicable to his own business. The industrial world is coming more and more to feel that all work is done under certain broad principles, and that the application of these principles to one industry is little different from the application to any other. The professor has felt, however, that his work is so radically different that he cannot apply the same standards of criticism to his work as obtain generally throughout other departments of life. In my opinion, a change is coming. If an educator is to possess his future in as full measure as is possible, he must invite criticism and help from wherever he can get it. The college professor must take the position that he is not an individual set apart, and that in the long run he must be governed and measured by the same general standards that generally obtain in the other occupations.

In discussions of the work of these institutions, the question of the pay of the teacher has played a large part. Everybody who has the best interests of higher education at heart is anxious that an honored profession such as that of the teacher should get better compensation. As one result of the writer's inspection of these eight colleges, he is convinced that the greatest progress in the matter of the increase in the compensation of college teachers will be obtained if the discussion can be made to culminate in a study looking toward an increase in their efficiency, which will result in larger work accomplished and hence in larger remuneration without relatively larger cost to the institutions.

In common with all other American institutions, our colleges have grown tremendously within the last two or three decades. With no assistance practically, except what they are able to develop for themselves, the teachers now find themselves fairly swamped. The educational side alone of the problem which confronts the professor has grown tremendously. The industrial development has brought further complications in the demands for specially trained men, and in addition to this there are the developments in pedagogy itself to keep up with, a task sufficient for any teacher. Thus it will be seen that, from the educational side, the teacher has had his problem unusually complicated. When one adds to this the fact that he has secured little

outside help on the administrative side, it is easy to see that there is excuse for his being literally swamped.

The impression that I gathered in the department of physics was that the professors were not thoroughly satisfied with the present pedagogical situation in their department. The necessity for research work, more fully treated elsewhere, increases the complication. The constant discoveries in physics are, from an educational standpoint, a disturbing factor. The growing importance attaching to science as an element in a liberal education and the rise of the elective system are other causes which have tended to make the problem of teaching physics a difficult one. In fact, the problem is one that requires for its solution an extremely high type of man. Granted that the problems are not being met to-day in an entirely satisfactory way, which of course can be said without any disparagement of the profession, progress must come about by giving the professors more time for their solution and by giving them all the assistance possible. Everything must be done to safeguard the time of the teacher. The higher his position, the larger will be the incentive for this. Now one of the principal ways of doing this will be in having much of his routine work done for him. It may even pay to have this work done in a manner not so efficient as the professor himself would do it, if thereby the time of the latter can be conserved for more important duties. This means the kind of efficiency that comes only through true coöperation, and until efficiency is used as the sole standard for the teaching profession, as it is coming to be used practically in all other walks of life, any goal satisfactory alike to the community and to the teacher will be difficult of attainment.

At the present time, after a comparatively small number of years passed in subordinate positions, the college teacher is made a professor at a tenure which is generally understood to be during good behavior, that is for life. Most educators consider this fixity of tenure highly desirable, and comparing it to the similar tenure of judges and officers of the military and naval services, endeavor to render it more generally applicable. To a business man, who feels that the essential principles underlying all employments are the same, the conviction grows that some day this life tenure may not be considered by the college professor as of real value to his profession.

It is certainly for the benefit of the community that all classes of teachers, and college teachers especially, be held up to as high a standard of efficiency as possible. What is for the benefit of the community will, in the long run, be for the benefit of the class. The question is whether the community secures more efficiency from college professors by guaranteeing to them as a class a life tenure in their offices as long as the service of any one of them remains above the level of an inefficiency that is notorious, or whether more general efficiency would be secured by fixing their tenure at that which obtains in the outside world, that is, guaranteeing to the professor the possession of his chair only so long as he remains the best man obtainable. It is evident that the correct answer to this question, like the determination of

tenure in civil government offices, involves social and other problems in addition to the problem of efficiency alone. Yet the decision that it would be dangerous to relax the life tenure of the professorial position because of the other elements involved might still render such a decision disadvantageous to the best men among the professors.

If the same standards of efficiency are to be applied to college teachers as are applied elsewhere, it will mean that when a man has ceased to be efficient he must be retired as he would in any other line of work; or if he no longer performs a given function in an efficient manner, that he be relieved of this function. Even if there were no such thing as life tenure in the college world, the consequences of insisting on the efficiency standard should not operate to the disadvantage of the college teacher. If A renders B good service through a long term of years, it is recognized that B has an obligation to A after his best years have gone by. Unfortunately, this obligation is difficult of standardization, but in most lines it is coming to be recognized as good business to accept the obligation in a large measure.

With all privileges cut out one would expect the same rule to apply which applies generally in the industrial world, *i.e.*, the more efficient the professor, the larger salary he will command, and this without undue regard for the salaries of others immediately about him, or for his own length of service. In other words, a man will not have to wait until he has advanced in years to get a satisfactory income. This will mean eliminating from the teaching profession those unfitted for the work,—a process which will have a good effect on the teachers who remain, because the whole standard of efficiency, and therefore the earning power, of the balance will be increased. A higher class will, in the long run, be attracted to the profession.

A further increase in the efficiency of the teaching staff will be obtained through such specializing as will come as the result of functional management. Without a more careful analysis, it is impossible to predict the extent to which this can be carried. There are some things, however, that are clear. During the interviews which the writer had with college professors, he found them spending time in taking inventories, keeping track of appropriations, mimeographing examination papers and handling routine correspondence. These things are clerical work, and should be handled outside of the teaching field, and not as a part of the teacher's duties. In addition, there are many other things, including management of the buildings and departments, which might easily be centralized and done better by officials who can devote their time exclusively to them. Such changes would leave the professor more time for the work for which he is especially fitted.

The effort should be made to segregate the important functions now being performed by the teacher, and then to arrange the scheme of management so that he will have the fullest opportunity to perform these well. The situation of the college professor, with his many and varied duties, is not unlike what would be the case in the profession of architecture, if the architect not only designed, but built his build-

ings. In that profession, the more distinguished the architect, the more strenuously he avoids being burdened with the details of erecting the buildings he creates. He calls in the contractor and the builder to handle this part, and in so doing he reserves for himself time and opportunity to pursue design. In the same way, I believe that the teacher will demand that through functional assistance he be relieved of those parts of his work which take him away from teaching and research.

A study of Table 5, giving a summarized analysis of the way in which the time of the different grades of college and university physics teachers is employed, will show that as a profession they probably spend less than three hours a day with students. This is the equivalent of what is generally called the "productive" time of other workers. The term "productive" is an unhappy one because it is undoubtedly true that even in the industrial world the so-called non-producers (those who do the planning) are among the most valuable factors in any concern. Still, in any study of the college teacher as a producer, his productive time, *i.e.*, the time he spends with his students, must first be determined. There are then open two ways of raising his productiveness: (1) by increasing the amount of productive time and (2) by raising his efficiency during this time. In other words, in studying the efficiency of any worker one must determine, first, what the worker is employed to do; second, it must be ascertained how much time he puts in on this work; and, third, it must be determined how relatively efficient he is while so engaged.

When a study is made of the teachers in other departments, it may be found that the teachers in physics teach a fewer number of hours per day than other teachers. This would certainly seem to be one of the effects which might be produced by the large amount of research. Then, again, in the languages there has been a larger effort at standardizing the teaching methods and mechanisms, and this undoubtedly permits of more teaching and less preparation. Judged by its monotony and arduousness, it would seem to the layman that a physics day, hour for hour, would be less tiring than one in language teaching, and therefore one would expect the average physics teacher to teach more hours per day than the average language teacher.

One change in the attitude of the teacher which may have to take place before his full efficiency can be realized involves his personal relation to his work. Nearly every college professor considers that the lectures that he gives and his pedagogical mechanisms are his own property. In the industrial world, a good workman is considered entirely apart from the appliances and tools which may be necessary for the pursuit of his occupation. In the same way, it is conceivable that the college professor will look at his work apart from his lecture notes and class-room methods and other mechanisms which help to make his work effective. At one institution I found the beginnings of this system. In the main administrative office of the physics department at Toronto there was a file of drawers in which were placed the lecture notes for all the different courses, written in rather a uniform style and all on standard sized cards. These lecture notes were the property of the professor in charge of the depart-

ment. But, as he explained, "they are available for all the members of my staff, who are encouraged to use them and who do use them and make them the basis of their lectures. You see by following such a procedure as this you make your men available for class work earlier. I have already spent many years of work putting these lecture notes into pedagogical sequence, and their being available for my instructors leaves their time free to develop other and new lecture courses or to carry on research work. It thus saves energy in the management of a large laboratory like my own."

It was not only considered proper for any member of the staff to consult, without giving any reason, any of these lecture notes, but the head of the department encouraged each member of the staff to make suggestions as to how they might be improved. Such improvements were continually being made, so that the value of this part of the departmental equipment was constantly appreciating.

What applies to lectures should apply with equal force to the various mechanisms used for examinations and in "setting up" lectures, etc. There are numbers of courses that remain practically unchanged from year to year, and which, especially in the sciences, involve considerable mechanical preparation. At the present time most of this is done either by the man who delivers the lecture, or by a laboratory assistant who has been trained to the work through years of practice. At every hour of the day in ordinary industrial establishments, work more complicated than this is done by ordinary workmen under written instructions. There is no reason why, for every such set of lectures, there should not be instructions, lists of apparatus, etc., which would practically relieve the professor of much subordinate work that now occupies his attention. The amount of time devoted to this general class of work will be shown by an examination of Tables 4 and 5, Part 2.

It is apparent that if a university is to follow even in a measure the industrial practice of furnishing the tools to its cultured and highly educated workmen, it must own tools to furnish. There appear to be only two honorable ways of securing title to such tools, *i.e.*, either by purchase outright or by employing men under the mutually and clearly understood agreement that a stipulated part of their time is to be devoted to working up standard lecture, laboratory and recitation-room exercises. Probably the better way will be to have it understood that this is an integral part of the pedagogical policy of the college, and that on account of this it is possible to pay higher salaries than would otherwise obtain. It will certainly be incumbent on any institution trying this plan to be liberal. It will be possible for the beginnings to be made in the standard courses like elementary physics and chemistry, without attempting it in the more advanced courses where it will be more difficult of application—especially in advance of getting experience on the simpler problems.

There are obvious hindrances to an immediate adoption of this idea in its broader phases, and other objections will doubtless be developed should any concerted effort

be made to put the policy into effect. This being granted, it seems to me that progress in the lower grades of teaching lies largely in this direction. I proposed this plan to a number of college professors, and, as may be imagined, I received replies all the way from a hearty acquiescence to refusal to believe that the scheme was in any respect worth a trial.

Undoubtedly, there is a good deal of the feeling that lectures to be good must in a way bear the marks of the inspiration of the moment. If it is right educationally, standardization will be well-nigh impossible. But a good many men who have the reputation of being high authorities assured me that the carefully thought out plan for a series of lectures would win out every time over the "inspiration of the moment" idea.

There is no desire to minimize the value of the personal element in lecturing. One man certainly does hold the attention of a class-room and inspire his students, while another may fail in both respects. The question is rather whether in most elementary and medium branches a true teacher will be handicapped by having to use textbooks or "standardized" (see page 6) lecture notes.

This question of standardizing laboratory and class-room exercises and lecture notes brings up the related one of the attitude toward assistants. Under modern scientific management the effort is made to select men for the lower grades who will in time develop into the higher positions. The larger number of men employed for the lower grades allows many to fall by the wayside for one reason or another. Even with this policy in general use, most business managers experience the frequent necessity for going outside the ranks of their own employees for men to fill the more desirable positions. I found the widest differences in the colleges in this matter. At Toronto the assistants were engaged largely in setting up lectures and in preparing the laboratories for section work. In preparing for lectures, they were supposed to perform all the experiments in order to make sure that the time of the lecturer would not be wasted when he went over them preparatory to the lecture. The head of the department told me that he believed in taking every possible precaution in order to insure that the lecture should go without a hitch. Sometimes four men were engaged in setting up a lecture, and if having an equal number present at the lecture raised its efficiency, he had them there. In order to make sure that the assistants who prepared for a lecture should do their work thoroughly, he frequently turned the lecture over to them at a point where an experiment was to be made. At Columbia, on the other hand, I was told that the assistants were made to understand that they were only "tolerated" on condition they did good research work. They practically held research fellowships, although they were called assistants. This policy of not training the new men into the teaching methods and ideals of the department does not seem advisable, because if they do not get this training early in their careers, it probably means that they will never get it.

It is obvious that the college professor does not realize how catholic his duties

are. To one who is familiar with the difficulties of management, the manifold duties carried on by the college professor seem overwhelming. I saw a single individual personally assume the direction of a large building including laboratories, machine shops, power plants, etc.; maintain order and discipline among seven hundred at times boisterous spirits; direct and inspire a teaching force of a score of rather unusually able men; lecture on the most attenuated physical theories; keep in touch with a large body of graduates; carry on research work, etc. We can be unsparing in our praise of the success which attended the work and yet realize how badly much of it must have been done, judged by any absolute standard. The college professor does not realize how many distinct functions he performs. The high-priced presidents of our railways, banks and steel companies would not dream of performing this variety of functions. They would refuse to do so because they know that they could not do them well.

This part of raising the efficiency of the college professor will have to be done by building up central agencies for doing much of the work he does now, and for doing it so much better than he possibly can, that he will be glad to relinquish his responsibilities in these respects.

If the colleges would maintain the proper kind of records, it would soon be possible for an instructor weak in any department of his work to call on some other college, or perhaps on some other instructor in his college, to help him with his work. The result would be that those who are specially proficient in their work would get credit for it. At the present time there is the tendency that one finds in the labor unions, to put men into a few classes, each class being maintained at a dead level which is usually lower than it need be.

Although I am unable to verify this conjecture, I believe that one reason for the demand for research workers is just a demand for established efficiency. I think if methods can be developed by which the success which a professor may be achieving, either in teaching or in administering his department, may be measured and recorded, that he will be in demand as the research workers are in demand. There is now, at best, only an indirect method of telling who are the competent men. If a man's competence in any line is once established, he need not worry to-day about getting adequate compensation,— if one man will not give him what he is worth, another will.

Another point which operates against efficiency of the teaching staff is their long hours. There is little effort made on the part of the teachers (and the responsibility for this does not alone rest with them) to determine what constitutes a day's work, and then to accomplish this within certain fixed hours. The college professor probably gets less help out of recreation, taken in its broadest sense, than almost any other class of worker. I met men who literally spent their lives in their laboratories, and it is impossible to believe that men with so little relaxation do not suffer from this excessive concentration. Thus one professor wrote: "You will perceive that my entire

time through the day is spent either in giving the courses which I present or in making preparation for them in one way or another. Besides this time I have spent the hours between 7.30 and 11.30 p.m. seven evenings in the week regularly in my office in the preparation of lecture notes for my students, and also the hours between 10 a.m and 1 p.m. and between 3 and 6 p.m. on Sunday in the same way." It is hardly possible that such hours would be permitted in an industrial establishment. The tendency is towards moderate but clearly determined hours of labor and an insistence on close application during the established hours.

With specialization, especially in administrative matters, will go a cutting down of the committee meetings, which have increased rapidly in the last few years. Almost every man interviewed complained of the amount of time spent in committee work. The schedules of the individual teachers summarized on Table 4 show comparatively little time spent on committee work; but as a source of interruption to the regular work of the teacher, committee meetings are undoubtedly a great, and in a large measure an unnecessary annoyance.

A further improvement in the lot of the college teacher, and especially those of the lower grades, would be a bureau through which men could be moved from one place to another with less difficulty than now obtains. In the long run, it is to the benefit of the colleges and of the teachers themselves that they should each be engaged at that place where they can work at their highest efficiency, and anything that tends to make it impossible for a man both to keep growing in his ability to perform and in the opportunity for having his abilities utilized is against progress. Everywhere I went I was told it was hard to get people, and hard to dispose of those who, for one reason or another, desired other engagements. To employ an assistant at six hundred dollars a year seemed to require an inordinate amount of correspondence, as much as for a man who was to get five thousand a year. At the same time I was introduced to a number of promising younger men who had just obtained the degree of Ph.D., and who were having considerable difficulty in securing employment as assistants.

In the Appendix, Exhibit A, I have given a sample of an employment bulletin issued once a month by the American Society of Mechanical Engineers. The same thing could be done by some collegiate agency. Standard blanks could be provided, calling for the precise information which experience shows the employer must have before reaching a decision. The correspondence in this matter shown me at the colleges was as unsatisfactory, from a business standpoint, as anything I saw. No one professor has occasion to employ men at frequent enough intervals to execute the work with much facility. I was told by several people that the commercial agencies do not give good results on teachers of collegiate grade. The charges were said to be high.

If the ease with which these men, especially those in higher positions, are moved about could be increased, it would have a marked effect in forcing on the colleges

a type of departmental organization that could be passed on from one set of men to another without imposing undue burdens on those assuming new duties. In the industrial era just back of us, a man taking a new position was expected to take at least six months or a year to get comfortable enough in his new environment to make it possible for him to perform his duties. Under present conditions, in the better organized companies a change in officers involves no such delay.

The whole question of salaries has been covered by the Carnegie Foundation in Bulletin Number 2, so that it hardly seems wise to more than touch upon the subject. In Table 3, Part 2, I have given the individual salaries paid the one hundred and one teachers included in this study and then summarized them in various ways.

In conclusion, I want to repeat that I believe very little profit to the college teacher can come of an abstract discussion of the wages paid men of this class, while I believe a great deal can be quickly accomplished in the matter of raising their compensation if coupled with it goes a broad study of efficiency and of methods of increasing that efficiency.

RESEARCH

At six of the eight institutions visited, research was considered an integral if not the most important part of the work of the physics department. At the other two institutions (Massachusetts Institute of Technology and Williams), while some research work was being done, it was not felt by those in charge that the opportunity for it was such as to warrant much emphasis being laid on research. At every one of these institutions I think it is hoped to make more of research in the near future rather than less. The fact that apparently there is to be a great increase in the energy with which research is to be pursued at the colleges makes research a vital matter in a study of the efficiency with which it is conducted.

Those teachers of physics who have done notable research work are undoubtedly those who are in the greatest demand. To have done research work is almost as essential for one holding a high place in a department of physics as it is for an instructor in any department to have a doctor's degree. This is a little difficult to understand in view of the obvious differences between research work in physics and the ordinary teaching of physics. It is certainly having a marked influence on the teachers of physics. Broadly speaking, I think that more than one half of the physics teachers I met are included in one of these two classes: first, those who would like to be relieved of undergraduate research work so as to give their efforts to developing the teaching side and, second, those who feel that their teaching hours are so much time taken away from research. The greater number of the workers in the various departments of physics are in this latter class. The feeling is so strong, the amount of effort and money going into research is so large as compared with what goes into teaching, that some of the places visited are research laboratories first, and after that, schools for teaching physics as a branch of general education.

One man high in the councils of his department told me that he felt that his abilities lay in the direction of teaching, and that the efforts that were being made to drive him into research work were against efficiency. He said that he had to accept it because of the feeling at his institution that they wanted as teachers only those who could do research. Another prominent physicist told me that the president of his institution kept the question, "What have you discovered to-day?" constantly on his lips as a spur to the members of the physics staff. Another asserted that because in the applied sciences it was so much easier to make notable discoveries than it was in physics and the other pure sciences, the latter suffered in the matter of appropriations. I gathered that research is one of the master words which open the coffers of the prosperous. It is not without interest to note, in this connection, that the American Physical Society, made up largely, if not exclusively, of the men of the universities, some time since decided that it will not receive papers devoted to the pedagogical or educational side of a physicist's work.

It would probably serve no good end to repeat here some of the extreme state-

ments made by the two sides to this controversy. It can be said, however, without fear of responsible contradiction, that in most of the subjects taught in the colleges to-day a man can become an acknowledged efficient teacher without adding materially to his professional reputation or his earning value. To accomplish the latter he must, generally speaking, do research work and publish the results of it in at least fairly technical language and in fairly technical publications.

Perhaps the establishment of highly paid chairs in various subjects, the occupants of which are to be specially distinguished for their ability to teach rather than for their research work, would have the tendency to remind the college world that there is still virtue in general instruction and professional teaching.

From an industrial viewpoint, the teaching of undergraduate physics and research in physics have little in common. At the present time both are handled by the same organization within the department of physics. No effort is made to separate them in any way. Research seems to require a quiet, dispassionate, more or less contemplative line of approach, whereas lecture-room work and recitation-room work must necessarily be more immediate.

I am not recommending that the universities as a class do less work in the matter of research, but it is my feeling that both the research and the teaching would be more efficiently done under a somewhat different organization than now obtains. It is true that some of the research work that is now being done is carried on under such conditions as to make it exceedingly expensive. For instance, owing to its location in a great city, Columbia University, though well equipped with both apparatus and eminent physicists, is barred out from research in many lines except during the three hours from two to five in the morning when the street cars are not running and other conditions are favorable. It would appear that unless this university can afford to maintain at some more advantageous point special research laboratories, it should abandon research in physics. It is certainly not in the interests of efficiency that men who everyone admits are specially qualified to do notable research work should have their hours of labor so restricted. These same unfavorable conditions for research were found in greater or less degree at most of the laboratories.

As far as I could discover, research had not made any notable progress in the undergraduate courses. At one institution they require an original piece of research work in the fourth year as a condition of graduation for those who take physics. This feature in the course was elsewhere generally condemned, and it seemed to be the consensus of opinion that standard laboratory exercises in all departments of physics were best designed to give results in teaching undergraduates. In certain instances, no doubt, individual teachers have been lured from this path, but it did not seem to represent any fixed or growing educational policy.

Another weak point, in my opinion, in the research work as it is carried on now at the colleges is that it is being done with the minimum of inspection and control. I believe that few workers can be at their maximum of efficiency unless their work is

subject to a fairly constant, intimate and impartial review of some kind. At present, the character of review which any piece of research work enjoys depends largely on the personal relations which may happen to exist between the research worker and his associates in his own department. Some work is done with practically no review, either because no one is interested in it, or if interested, no one feels warranted in offering suggestions or criticisms. I was shown one piece of work which had been in progress for over two years which, in the opinion of several who had had an opportunity to study it, was a sheer waste of time. And yet no one protested because no one felt he had the authority. Even when research work is done by a physicist who is not only intimate with his associates, but who seeks their opinions, it is not as apt to be checked where it is wrong and encouraged where it is right as efficiently as it would be by equally able scientists not brought into such intimate day-to-day contact with the department. Of course, like everything else, such a system of inspection would admit of exceptions in notable cases.

For this reason it seems to me that in every institution doing research work there should be a "general research board," whose duty it would be to organize the general policy of the institution in the matter of research, to bring about as much cooperation as possible between the departments, to correlate as much as possible research work going on in different sciences, to procure assistance for those needing it, to pass on the expediency of undertaking any given project, and to keep constant track of the progress of work and of its cost. Such a board would probably find it advisable to keep as far away as possible from the details of the work of research and to assume toward it the same broad viewpoint as has been recommended for the board of trustees to take in relation to the general work of the institution. In fact such a board would act as the board of directors of a research laboratory, made up of all the research laboratories of the institution. I am sure that the existence of such a board would make for efficiency. This might easily lead to a "director of research," and for such a functional officer there would appear to be plenty of work to do.

In the introduction, there was suggested the necessity for caution in applying industrial standards in the matter of the cost of research. There is in all research work, of course, an element of chance. Many brilliantly conceived investigations fail for reasons unforeseeable at the time that they are undertaken. Time is not a controlling consideration in research work. And yet it will hardly be denied that over a term of years, and viewed broadly, there should be some relation between cost and product. To discover such a relation is likely to become increasingly important because every authority interviewed assured me that it was becoming increasingly difficult to discover profitable lines of research.

Of course every professional man is supposed to be something of a research worker —it is hardly possible for him to keep out of it. In this report, however, I have not had this kind of research in mind. I have had in mind rather that done during "working hours," and done, therefore, with the full approval of the institution at

which it is performed, and largely at its expense. For some of these institutions, the value of research to teaching must be its test. I believe there is a distinct disadvantage to undergraduate students to be near research work. There is a certain inspirational value in the presence of men who have "done things" in a science one happens to be studying. Is there not danger of exaggerating this value? I think in the case of physics research workers, this influence is more than offset by the introduction into the undergraduate laboratories of the necessarily deliberative and experimental methods of the research laboratory.

At none of the institutions visited was there any means of controlling the amount of research work done in the various departments except through the general departmental appropriations. Given an appropriation of $3000 or $10,000, in every case the considerations which ordained how much of this money should go into research and how much into teaching lay within the department. These considerations for the most part had to do with the idiosyncrasies of individuals connected with the department rather than with conclusions reached by the department officially. In other words, the proportion of any departmental appropriation which goes into teaching must necessarily be largely a haphazard matter. It cannot be otherwise because there is no machinery for regulating it elsewhere. In fact no one connected with any of the departments studied knows, even in the broadest way, the relative cost of teaching and of research.

On Table 7, Part 2, an effort has been made to separate the cost of research from the cost of teaching. The same has been done for the direct expenses connected with teaching and research. Cost here includes such items as interest on plant and equipment, and it includes physics' share in the administrative expenses of the institution. The direct expense includes only items involving a cash outlay and those which under proper management would be under the control of the departmental authorities.

The total cost of physics and the direct expense of physics at eight institutions may be divided as follows between research and teaching:

	Cost		Direct Expense	
	Research	*Teaching*	*Research*	*Teaching*
Columbia	$27,520.88	$62,917.23	$14,203.78	$31,923.09
Harvard	36,925.49	33,958.35	25,749.90	21,506.76
Haverford	840.79	4,582.16	401.79	2,054.06
Mass. Inst. Tech.	8,930.50	58,122.73	6,049.57	28,481.43
Princeton	27,229.65	57,312.93	16,672.00	28,638.00
Toronto	12,399.18	50,126.72	6,614.76	22,309.37
Williams	465.83	12,007.35	273.07	5,470.43
Wisconsin	15,578.85	33,297.99	11,059.45	22,397.39
Totals	$129,891.17	$312,325.46	$81,024.32	$162,780.53
Average	29.4 *per cent*	70.6 *per cent*	33.2 *per cent*	66.8 *per cent*

An auditor sent in to audit the accounts of these institutions would inquire as to the warrant for the expenditure of such large sums on research. At five of these institutions the money devoted to research represents not only a considerable proportion of the income of the department, but a considerable amount of money. At no one of these five institutions are there funds available for research which anywhere near equal what is spent. At Harvard, for instance, the endowment for research in physics is in the neighborhood of $90,000, which at five per cent would yield less than $5000 per annum. The expenditures for research appear to be five times this amount, or in excess of $25,000. There are certain annually made gifts and annually renewed guarantees for research which may amount to $1000 or $2000 more in any one year. It is impossible under the present system of accounting to be more definite. But allowing the outside figure ($2000), it still leaves over $18,000 spent on research out of the general educational funds of the institution. As is pointed out elsewhere, considerable expenditures are also made for research at Harvard which do not pass through the books of the treasurer.

By research work, as used here and elsewhere in this report, is meant research work done by the teaching staff, and in which the student body have no part. For this reason every effort has been made to exclude from the charges against research the expense connected with student research work and its supervision. It is difficult then to see how, under these conditions, "research" can be considered as being in any sense tuition. It can have only an indirect bearing on the teaching proper, in so far as it develops the teachers themselves.

It would be good policy to separate departmental expenses between teaching and research. While this would involve a considerable departure from the present bookkeeping methods in use at the universities, it would be a simple matter from an accounting standpoint. If there were to be established a general research board, it would pay to keep the research expense of each department divided further between the various undertakings. This would involve little additional expense. But without a central board to use it, it would not be worth anything. The departmental organizations as now constituted would not make enough use of it to warrant a slight expense.

It is fair to call attention to the fact that physics is one of the principal research branches. Perhaps the large interest in research which I found everywhere in physics is considerably in excess of the average which obtains in other branches of university teaching. But in physics it is true that even on the teaching side the individual student who gives promise of becoming a research worker, or who is going into physics as a life work, receives the lion's share of attention. At some places the large undergraduate classes of students who were studying physics simply as a culture study were looked upon as the least important part of the work of the department.

THE ECONOMICAL USE OF BUILDINGS

If there is one thing that stands out as an example of inefficiency, it is the degree of use to which college buildings are put. Dr. Van Hise, president of the University of Wisconsin, told the writer that he had recently conducted an investigation of one of the main buildings of his university, and had found that the rooms in it devoted to teaching were used only, on an average, three hours a day. He had been very much surprised by this, and had notified the professors occupying the building that he would not ask the state legislature for any more money for their departments until they increased the average use of the rooms under their control. Dr. Van Hise thought that this was a very bad record, but as far as I was able to determine, there are no recitation rooms or lecture halls in which physics is taught at any institution, that are occupied more than four hours a day, and the average use of such rooms is less than three hours a day. Laboratories may possibly be used more efficiently. I found one magnificent lecture hall on the second floor of a building, standing on land that is worth approximately twenty-five dollars a square foot, in use six hours a week—and this an institution (Mass. Inst. of Tech.) which is undoubtedly handicapped for lack of room.

It is possible that, owing to special conditions found only in the department of physics, the rooms devoted to physics are not used as continuously or as efficiently as they are in some other departments. So I present some figures secured at Williams College, where this matter of the efficient use of buildings had already had some thought and was still receiving their attention. I give the use per week of twenty-three rooms, located in three different buildings, in which modern and ancient languages, economics, mathematics, etc., are taught.

	Room number	*Hours per week*
Hopkins Hall	4	24
	5	3
	6	21
	7	18
	8	24
	10	22
	11	24
	12	3
	13	3
	15	19
	16	3
		164 ÷ 11 × 6 *is* 2.5 *hours a day for the building*
Griffin Hall	1	19
	2	19
	4	22
	5	29
	6	27
	7	17
		133 ÷ 6 × 6 *is* 3.7 *hours a day for the building*

	Room number	*Hours per week*
Goodrich Hall	1	15
	2	9
	3	14
	4	18
	6	21
	7	32
		109 ÷ 6 × 6 *is* 3 *hours a day for the building*

The average use for the entire twenty-five rooms is 2.83 hours a day.

Since writing the foregoing, I have secured the record of occupancy for seven rooms used principally for physics and mathematics in Fayerweather Hall at Columbia University, where space of course is at a premium. The numbers across the top are room numbers:

	301	304	506	604	609	613	615	*Totals*
Mon.	2	2	5	5	4	5	4	27
Tues.	3	3	2	3	2	5	3	21
Wed.	2	5	5	6	7	6	4	35
Thurs.	3	4	2	2	4	5	3	23
Fri.	2	4	4	5	5	1	3	24
Sat.	2	3	2	2	2	2	2	15
	14	21	20	23	24	24	19	145

Adding the total hours in use per week for each room and dividing by seven (the number of rooms) times six (the number of week days), we get 3.45 hours as the average use per day per room. It will be noticed from the totals on the right that on some days the rooms are used much more efficiently than on others. On Wednesday, for instance, the average use is five hours, while on Tuesday it is only three, and Saturday a little above two. That there is no insuperable reason why rooms cannot be used more economically is shown by the fact that instances of six and seven hours' use are shown. The poorest record here is Room No. 301, a room reserved for the exclusive use of the physics department. With the exception of No. 304, the other rooms are used by more than one department. The authorities at Columbia had evidently given this matter thought and had subjected it to some control. I doubt if any better showing can be made by any other building anywhere.

In the first place, the management of all buildings should be in the hands of some central authority and operated under as complete rules as can be established; the same rules, of course, applying to all buildings, no matter what the purposes for which they are used. These rules should be public. It is impossible for the various rooms to be used economically if they are administered by the departments nominally in control of the buildings in which they are located. A professor in one department has not the information about the conditions in another department that would make it possible for him either to lend the rooms or borrow them to advantage. This is what they are supposed to do now, and there is little of it done.

In this proposed interchange of rooms between departments, there is not included

any suggestion that a room not entirely suited to a given purpose shall be used for that purpose. It might be disconcerting, for instance, to a section in Greek to have to hold a recitation in a room that, on account of the necessities of the biological department, was filled with the latter's equipment. My impression is that this is what is going on now more or less and will become more the rule, unless some central agency is given the means of studying the common good and also given authority to enforce its conclusions.

There should be greater publicity in regard to the buildings themselves. The cloistered idea as applied to the university as a whole has nearly disappeared, but the departmental cloister in some instances is still intact. There should be printed floor plans in miniature for every building, and these should be generally available. On these plans should be given the physical features of each room, the number of seats and size of blackboards, the character of the ventilation, etc. It should be possible to tell from the plan, and without seeing the room, how useful for a given purpose it would be. There should also be given on these plans the charge for the use of the rooms figured on the basis of the cost of maintaining and operating the building in which the room is located. In this way rooms in the more undesirable buildings could be given a preferential rate. And even in the same building, the fewer facilities a room possessed, the lower might be the rate.

Rooms will then be reserved by a department under one of two plans: (1) reserved for its exclusive use at all times, and (2) reserved for its use only at certain stated times. This will mean that buildings and quarters in these buildings will belong to departments only when they reserve them and pay for them. This will put a premium on a department's getting on with as little room as possible. It will also mean that, other things being equal, a teacher will not want a room that is twice too large for the section he is to teach. If a uniform system of numbering is provided, whereby the same number will indicate the same room in any building, and periodical lists are prepared showing the use to which the various rooms are put, and giving the lists of those rooms which are available for various kinds of assignments, the publicity alone involved in this will immediately result, I am tempted to say, in a twenty-five per cent increase in the efficiency with which rooms are used.

This interchange in the matter of the use of rooms between different educational departments may be difficult to introduce, but it can be assisted in various ways. In the first place, each university should have set standards covering size and design of rooms used for certain purposes. At the present time, a lecture room for physics is apt to be different from a lecture room in chemistry; *i.e.*, the points in which they must necessarily differ are accentuated rather than the points in which they may be alike. The same thing applies to all other rooms. There is no reason why a recitation room providing twenty seats for students in physics should not as to dimensions be exactly like a recitation room with twenty seats for students in mathematics or any other subject. If there is any inherent difference in construction on account of the

use to which they would be put, this difference should be so made that, if at some future time the disposition of the room is different, a change can be made at little cost and without spoiling the efficiency of the room for its new purpose.

This point of using, or not using, the same room for different purposes can be well illustrated in the cases of two large lecture rooms which the writer visited. One of them at the Massachusetts Institute of Technology was reserved for a lecture in elementary physics which took place six mornings in the week at eleven o'clock. Owing to the fact that the room was made more or less a storehouse for physics apparatus, it was rarely allowed to be used for any other purpose. On the other hand, at the University of Toronto, the far-sighted professor in charge of the department had seen to it that in the construction of his lecture table every wire and pipe had a connection both above and below the floor, so that on an hour's notice it could be removed and a piece of flooring already provided be put in place and the room turned over to the Cercle Française. Instead of having a fixed blackboard back of the lecture table, he had both the board and the partition back of it so suspended that when the room was to be used for theatrical purposes they could be raised entirely out of view, thus providing both stage and flies for a neat little theater. This professor also insisted that all apparatus be removed from this and the other lecture halls at the conclusion of the exercise at which the apparatus was used. I have recently been told that at the Massachusetts Institute of Technology in certain courses (not in physics) the lecture tables are set up entirely outside of the lecture room and rolled in and out on tracks provided for this purpose. This allows the room to be used for lecturing at the same time that preparations for the next lecture are going on in another room.

A great deal of money could be saved and mistakes and annoyances prevented if experience gained by one institution in building could be exchanged with others. My attention was called to what seemed to me serious mistakes in most of the physics buildings visited. Many of them were such as could not have been foreseen, but as far as I can see the next university erecting a physics building is as apt to make the same mistakes. If all plans for buildings were filed in such a way as to be easy of access, I am sure that those about to build would be glad to profit by what others had done. This does not pay now, because it is only the exception when plans are readily available.

With standard designs for lecture halls, laboratories and recitation rooms, and a certain procedure required in the way of adequate authorization before changes from these designs could be made, our university buildings would in a short time be put on a standard basis that would permit of a much larger daily use.

The architects of university buildings do not always seem to have in mind the same ideas as to economy of space which they would observe in other classes of buildings. In nearly every physics building I found many rooms designated as a "sort of storeroom." There is relatively no more occasion for an excess of storerooms in a physical laboratory than there is in a hotel or a manufacturing establishment. But

their architecture usually includes rooms that on account of light or size cannot be used for anything else.

At least three buildings of those visited have towers running from the basement to the ceiling to be used for experiments requiring dropping weights, suspending pendulums, etc. This is at best an intermittent use; sometimes such a tower is not used during a term of years. By putting removable floors in a series of closets, one over the other, such a tower would be afforded, should occasion arise for its use; or the main stairway could be utilized for this purpose as was done at the University of Wisconsin. In the meantime, valuable space would not be put out of commission, and would not have to be kept heated. It was suggested to me that this tower was looked upon by a good many physicists as of largely traditional value.

The architect of the University of Wisconsin had two large scales laid off in feet and inches, beginning at the same corner and running as a frieze around two sides of his consultation room. He said that he tried to arrange it so that, when he was being given instructions covering the size of rooms, the person giving the directions could sit where he could see the scales. He said that otherwise the size of every room would be larger than required for the purpose. He also had placed in the room samples of such standard articles of furniture as roll top desks, revolving bookcases, etc., as a further guide.

My attention was directed to the fact that in the Princeton building the architect had placed the instructor's desk in each recitation room in the center of the space immediately in front of the students' desks. In each room the instructor's desk had been moved to a position in the corner so as to provide a space where the instructor could walk as he taught; the end of the pipe which had carried the electric light wires protruding through the floor in the middle of the promenade must afford a constant diversion. The desks are, of course, without means of artificial light in their present position. The original lay-out of each room is that used in country schoolhouses from time immemorial. It is certainly possible to do some profitable standardization here.

It appeared to me that there is a very considerable disadvantage in small buildings, such as I found at Williams College. When the existing departmental lines are largely broken down, it is going to be possible to handle departmental work much more efficiently if the janitors, laboratory attendants, storerooms, etc., can be shared. When the buildings are relatively small, this will be more difficult.

One measure that will make possible a larger use of rooms is the shifting of the hours at which certain lectures and recitations occur. It used to be accepted that all recitations must occur in the morning and laboratory practice in the afternoon. Gradually, this old order has been more or less modified, but if a central authority, such as a registrar, had to pass on all schedules and would study each with regard to its relations to all the others and to the buildings that were available, much further progress could be made.

I found everywhere evidences that among both the students and the teachers there were strong likes and dislikes for exercises occurring at certain hours in the day. At Williams College exercises began at 7.45 in order that there might be none after four in the afternoon. Students generally avoid those electives which call for a single hour in the middle of the afternoon.

Another factor which militates against the more economical use of the rooms is the order in which the rooms are left and their ventilation. At the University of Toronto I found the physics building a model from the standpoint of ventilation, while in the main building, which happened to be an older one, the atmosphere was almost unbearable. I could see that any professor would prefer to use a room for a recitation or a lecture which had not been in use the hour before. So that, before any large improvement can come about, standards both for order and ventilation must be established.

At the University of Toronto, after every laboratory exercise the apparatus which has been in use by the students is put away. If it is bulky and the table large, the apparatus is placed at the far end of the table and lined up with it. A neat unbleached muslin covering is then placed over it. In other words, each section leaves the laboratory free for the use of any section that comes after it, and the remarkable part of this is that in this particular laboratory there is so much space that there is no necessity for its conservation. It is done, I was informed, largely out of consideration for the development of the characters of the students and to teach them habits of neatness. I have never seen such a well-ordered building anywhere. Any industrial establishment with which I am familiar can learn from the Physics Department of the University of Toronto in the matter of housekeeping. Every other laboratory I visited had more or less to criticise in this respect.

There are many questions of general application which would be developed as a result of a detailed study of this matter of the use of rooms. For instance, it almost invariably happens that recitation rooms are put on the top floors; while museums, apparatus rooms and studies are on the lower floors. To the layman it would appear that a room which is to house anywhere from twenty to a hundred students for, say, four or five hours every day, should be nearer the ground floor than a museum which is visited only occasionally.

The more thought one gives to this matter of the ownership and exclusive occupation of a building by a department, the more wasteful it appears to be. Under this plan there must be either a feast or a famine. If a building is constructed with an eye to the future, it must necessarily be too large for the present. There is a question of policy here which must be threshed out. At the University of Toronto the physics building was so constructed that it looked forward to only a few years' growth, but could easily be enlarged in accordance with a predetermined plan. At Princeton they told me that they had had at least twenty-five years' and probably fifty years' growth in mind at the time the building was constructed; yet out of the

one hundred rooms in the building none was used by interests foreign to physics. The physics staff did some work in the department of electrical engineering, which occupied approximately one fifteenth of the floor space in the building. In other words, the physics and electrical engineering departments were spreading out in the space that it was believed would be large enough to handle the requirements of these and other departments twenty-five years from date. Unless Princeton has too many buildings one would expect that there might be some department—at least part of a department—which might enjoy, say for the next ten years, some of this space provided for a twenty-five years' growth.

Again it may happen that a particular building is a gift carrying with it restrictions as to its use. Could not a method be arranged by which other departments could occupy unused parts of such a building subject to the payment of a satisfactory rental? This would afford one way for a department temporarily in possession of too much room to increase its "earnings." Such an arrangement, of course, would be possible only under an accounting system, such as is elsewhere recommended.

On Table 6, Part 2, I have given data about each of the buildings visited, including the amount of space devoted to lecture rooms, laboratories, etc., the cost of maintenance per square foot, etc.

FUNCTIONAL ACTIVITIES

Before it will be possible for those in charge of the various departments to relinquish any of the manifold duties which they now perform, it will be necessary to build up the agencies by which these functions can be more advantageously performed. Every effort should be made in building up these agencies to put them in competent hands. It will be found that duties will be willingly relinquished to those who will discharge them more efficiently. On the other hand, it will be impossible to convince a college professor that it will make for efficiency to take a duty away from him and give it to some one who is going to perform it in an indifferent manner. The best progress will be made in organizing these functional activities to do them only as they can be well done. It will probably be best not to require that everybody use a given functional agency when it is first started. A purchasing agent, on assuming his duties, will probably find his time fully occupied doing the buying for those parts of the institution which are anxious to utilize his services. It is of importance that those who first come in contact with the work of these functional agencies shall be impressed with their efficiency and genuine helpfulness. It will be better, therefore, for the purchasing agent to give an excess of time to making a few purchases, and have them made right, than to force his services on those who have not been convinced that they require them. If this policy is followed, practically every one will be using the purchasing agent within a year or two, and this without the necessity for forcing his services on any one. In this and other matters there will always be people who are glad to be relieved of trouble.

With so little of the work of our universities now being done on a functional basis, it is hard to predict the field it may ultimately cover. I have given brief outlines of those functions the development of which seem the most obvious, from which the greatest amount of help can be expected, and which in my opinion can be instituted with the least trouble.

Superintendent of Grounds and Buildings

This office can be made more valuable, even at those institutions where the position is now of considerable importance. If, for instance, the superintendent of grounds and buildings operates the power plant, it would appear that he should also have charge of all shops. To the layman in educational matters, there does not seem to be any good reason why, as is the case at the University of Toronto, three machine shops should be operated inside the college grounds,[1] and each of these be directed by one or more college professors, weighted down as they are with other functions foreign to this one. Each of these shops requires the same sort of supplies, the same character of employees, is doing the same kind of work,—work more closely allied to

[1] These three shops were connected with the work in physics. There may have been others connected with other departments.

power-plant work than to class-room work. The professors now in charge would soon find out that, instead of getting poorer service under a centralized management, they would get better service than is possible under existing conditions. The industrial world has now freed itself from the slavery of the idea that to get a thing well done you must do it yourself. Specialization has made almost the opposite of this true. I am confident, for instance, that every one of the professors who has duties in connection with the management of shops, and with whom I talked, is firmly convinced that, if his particular shop were under the control of any one outside his department, (1) he would have to wait longer for things, (2) the work would not be so well done, and (3) would not cost less. Most managers in the industrial world will be willing to admit that, if all work done by mechanics throughout a university plant should be done under the control of some central authority, it will be done better both from the standpoint of the university as a whole and also from the standpoint of the individual department.

At the University of Wisconsin I found that the professor in charge of the department had spent considerable time (and over a period of years) in getting the pendulum required in the Foucault experiment so suspended from the roof of the building as to give good results. This professor, a man of some years, had himself personally climbed into the rafters of a high building and attempted to make the adjustments in large measure with his own hands. At Princeton a shaft in the new building has been reserved in which a Foucault pendulum is to be suspended, but owing to the professors being engaged with other matters the pendulum has not been put in place, much to the disappointment of those who take a special interest in the new building. As long as each department is self-contained and is supposed to do largely for itself, such conditions must continue. Under what would appear to be reasonable management, such work as this would be done on the more or less detailed requisition of the departments by the superintendent of grounds and buildings, who would have at his command competent mechanics. If the amount of work to be done increased, he would know how to add to his staff until the work was got out of the way. This is not usually possible in the case of individual departments.

Interdepartmental Janitor Service

The typical college building has its own janitor, and there is no connection between the janitor service of one building and that of another. At one university there is a corps of janitors who have entire charge of the buildings in the university, and naturally the work can be done much more efficiently and at less cost. Janitor service generally among colleges can be much improved. There is no reason why the same standard of cleanliness should not obtain throughout all departments. Will not the professors be much more comfortable if their buildings are maintained in proper order without their giving it any thought, than if they have to be constantly bothering with such detail?

A sharp line should be drawn, probably, between the cleaning of the buildings and the care of apparatus, etc., such as is used in lecture halls and laboratories. It might later on be found advisable to build up a department of laboratory attendance, or to handle this work as a part of the janitor's department. It usually happens that in any one laboratory the services of an attendant are required only at certain given hours, and it might tend to efficiency to have a central organization that could send the same man to one laboratory at one hour, and to another laboratory at a different hour. Such coöperation under the present arrangement is out of the question.

Purchasing Department

In the matter of the purchasing department, perhaps, the college world is further away from the industrial world than in any other respect. At the University of Toronto they had had the question of the advisability of a purchasing department before them for several years, and it had just been decided that it was impossible for anybody to make purchases as well as a professor could make them; in other words, that the question of the advisability of a central purchasing bureau, which has long since been an element in the organization of all industrial establishments, could have no place in the collegiate organization. The reasons for this decision do not seem to me valid ones.[1]

At the University of Wisconsin they had definitely made up their minds that they would have a purchasing department, and had instituted a line of procedure leading to its installation which would take about two years to put in full operation. They had wisely decided to approach the problem slowly in order to demonstrate to the teachers and others concerned that the department could help them, before they made it necessary for any one to accept its good offices. In the writer's opinion, a ten per cent saving on all purchases is assured, and a larger one on a good many lines would probably be secured, as a result of the central purchasing authority. After all, the chief value of the purchasing department is not in the money saving, but in the matter of being able to secure the articles best adapted to the purposes to which they are to be put, an increase in the speed of delivery, and a greater convenience in making the purchases.

The influence of a satisfactory adjustment of the purchasing problem will spread further than might be supposed. I think that a good deal of the teacher's distrust of modern business methods may be accounted for by what he has seen of the almost ludicrous makeshifts for a genuinely efficient purchasing system. The accounting authorities have been forced to do something toward controlling expenditures or at least toward collating them. And the minimum of what they have been allowed or able to do has not been always such as would command confidence in what might result from a further development of "business methods." No one is to blame for this, but it would appear to be a condition easily remedied.

[1] Since writing the report the author has been advised that "the board of governors desires that there should be a central purchasing bureau. The experiment is in process."

College professors are undoubtedly experts when it comes to purchasing many articles pertaining to their specialties. They have not always realized that almost any large concern, like a railroad system or a steel plant, buys things every day which require the services of not one but in some cases of several experts. They have not always realized that any proper system of making purchases for a university will include the making use of every bit of expert assistance available where such assistance is required. Largely on account of this misunderstanding, the professor has burdened himself with the purchase of ninety-nine articles like pencils and paper so as to be able to pass on one article like a crystal or a piece of wire for a Foucault pendulum.

Stores Department

Nothing approaching a stores department was found, although the University of Wisconsin looked forward to a time when they would have a central storeroom where everything used in the departments could be obtained. They pointed out the fact that many of the things used in any laboratory were usually in demand in the others, and that there was no good reason why time and money and convenience would not be saved with a central depository. There are many articles which it is not wise for a departmental storeroom to carry which might profitably be carried by a storeroom used by all departments.

Mail Handling

The amount of mail that comes to a university which could not under proper organization be handled at a central office is small. Yet everywhere I went I found teachers engaged in writing notes, sometimes by long hand, on matters many of which could have been more authoritatively answered by a central office.

The layman would be surprised to know how frequently those connected with the scientific departments of our universities are called on for technical help which is to be given without compensation. It would seem to me that in every case such help should go out from the university rather than from the department, and under some single policy rather than under the different policies of separate departments as at present. Practically all mail should be answered at a central office, this office communicating by written memoranda with the departments when necessary. As far as I could discover, there was no evidence of any department's having enough mail legitimately its own to warrant building up the mechanism within the department with which to handle it properly.

Bursar's Department

The treasurer, as a rule, is not in close enough touch with the university to keep any proper track of details. This is recognized in the *Report of the Treasurer and Business Manager of the Northwestern University*, 1907–1908, in which the treasurer's report takes one page and the business manager's the balance of the one hun-

dred and sixty page book. The treasurer will, at most institutions, have to be a man drawn from the ranks of the laity and one not a member of the immediate university family. There should be, therefore, another officer in authority in matters of finance, giving up his whole time to the work, who will make it his business to study the details of expenditures and receipts so that he may be able to bear his share in making those improvements in methods which are considered essential in every commercial or industrial undertaking. It makes little difference what this man is called, —a bursar, comptroller, or business manager,—although the latter title seems to describe what I believe should be his general functions better than any other. The work of this kind now done is being done by those whose position in the whole scheme of university management does not seem to warrant their making suggestions as to the improvements which in many cases must be obvious to them.

If the student-hour were adopted and an effort made to keep track, not only of the details of the cost per student-hour in each of the departments, but of the receipts as well, this officer would have a large field of usefulness open to him.

Disciplinarian

In many industrial establishments, the matter of discipline comes up so rarely that one is apt to forget that there is any provision made for it. In the most developed establishments, the value of having all such matters managed by one person is well understood. At some of the universities these matters are attended to largely by one person, but this person is usually so overloaded with other duties that there can be little method in the handling of matters of discipline.

In this particular the lack of definite standards seems particularly noticeable when one considers how long the college men have been facing its problems. There are some published rules. At Williams a book of "Laws" and a book of "Administrative Rules" seemed to afford a good basis for what might, in my opinion, be profitably expanded. Similar publications were found at most of the institutions visited.

But there is reluctance everywhere noticeable in the college world to put things into writing. I mention it here because in matters of discipline it was especially noticeable. The reason for this seems to be that even in minor affairs the personal element is considered of much importance. The students, professors and everybody connected with the institutions are educated to feel that a given sequence of events does not always lead to the same result in matters disciplinary. I feel that this not only wastes time in disposing of such matters, but must have a bad effect on all concerned. If offences are committed, the punishments depend too largely on who committed the offences, their past records, circumstances surrounding the act, etc. In the large affairs of life this might pay, but in such minor matters as student escapades, absences, etc., it leaves too much leeway. A dean at one institution told me that the rules to turn back a student on failure to pass freshman final examinations were clear, but that until recently they never were put in operation without a hearing on

each individual case, and that even then they were rarely enforced. Then, owing largely to committee management, those dealing with such cases are in constant dread of being reversed, and as a matter of fact a large number of cases are constantly being opened up and revised.

I want to offer another reason for this condition, and that is that our universities and colleges are more afraid of publicity than is supposed. President Garfield told me that he believed that the remedy for most of the troubles of the colleges was more publicity. There is very little of it at present. High officers at several universities said that the fear of taxation made them backward about stating the value of their property. The treasurer of one university told me that he had purposely refrained from acquiring the information necessary properly to inventory the value of the plant. He wanted to be able to say that he did not know. I was told at one place that they would regret extremely to reduce to writing their rules on the use of intoxicants by students. The rules seemed to me to be fairly rigorous, but because they were not prohibitory it was feared that their publication would cause trouble. With no written regulations it becomes necessary, as might be expected, for professors of distinction constantly to give time to such cases. Complete standards rigorously enforced covering matters of discipline will reduce the occasions for their use in a large degree.

Bureau of Publicity

All printed matter intended for the public should be prepared in one place and under the direction of some one who understands this sort of thing. When assistance is rendered by the departments, it should be subject to the editing of this central bureau. Nearly all college catalogues, and in fact college literature of all kinds, too clearly bear the mark of their process of evolution. To the layman, they are unintelligible in large part, full of repetitions, giving a great deal of information in which it is hardly possible that any large number of people are interested, and withholding much that would be of interest. Nearly every college stands for something distinct in education. They all claim to do so when you ask the question. Nearly every department in the college has a policy it is working on, or some field peculiar to itself that it is trying to cover. And yet, in studying their literature, it is very difficult oftentimes to discover this. A parent or a student, engaged in looking into the relative merits of different colleges, should be able to find out what each one is trying to do in its own field. In this way possibly a good many of the misfits which we see all about us would be prevented. The editors of college catalogues must learn that it is not enough to state a thing correctly, but it must be stated so that the average person who reads it can understand it.

At no two of the colleges visited was the same system for designating courses in use. Several of these systems were almost impossible for an outsider to understand. One would think that some system could be arranged for this purpose which all

could use. The matter of designating courses is not the only place where it will be necessary to have a uniform system of nomenclature before it will be possible to get very far in the scientific study of the problems involved. No science, such as geology or botany for instance, would be considered to have developed very far if it did not possess a generally recognized terminology. It was suggested to me that in some of these matters it will be better to design an entirely new system than to attempt to build even on the best of those now in use. Wherever possible such a system should be made mnemonic.

There does not seem to be any special advantage in the extreme variety of typography and format found in college catalogues. The editors of many of the technical publications issued by learned societies are trying to bring their publications to standard size and to use for them a standard face and size of type. This change in college catalogues would mean a reduced cost, and in the case of many such publications—if not in all—an improved book.

The whole class of work included in advertising, circulars, the sending out of invitations, and the maintenance of the alumni lists should be done in this same department. For reasons of economy a large part of the student body may come from the territory immediately adjacent to the college. But in order to give a college a cosmopolitan atmosphere, it is desirable to have other sections of the country and foreign countries represented. By means of the checking and encouraging through advertising, this could be closely regulated. This same publicity department could be used indirectly for securing positions both for students during the summer months and for graduates after they have finished their college work. Many colleges have the beginnings of such a department, but it will never amount to what it should until each department refers all work of this kind to a special central department, and assists in strengthening this organization. I found some departments maintaining separate alumni lists of their own departments.

This whole matter, including the use of the word "advertising," is one that may be very differently received in different places. It seems safe to say that whatever work of this kind is done should be done by the authority of the university or college as a whole, and under the direction of the best specially qualified person whose services can be commanded.

There is a marked tendency on the part of the universities to make their literature more attractive. The pamphlets of the Harvard Graduate School are the first instances I have seen of color work in college advertising matter.

It is a question whether commercial advertising should be imitated by educational institutions; if so, how far and under what restrictions. If a manufacturer finds that he has a plant capable of a substantial increase in product with a comparatively small increase in wages, he makes this increase feeling that he is reducing his cost of production. To market this product usually involves advertising. When a university finds that it has a department with the material equipment capable of handling, say,

three times the number of students, good administration would suggest the advisability of advertising that particular department, and perhaps of cutting down the advertising of the departments already overtaxed. I found exactly the opposite condition at one place where they had an excellent equipment for handling at least three times their present student body in one department, yet the ranking professor rather apologized for a modest piece of advertising matter which he placed in my hands, and which he was glad to say had not been sent out by his instructions. He said that he would welcome more students, but he felt that the function of the university had been entirely fulfilled when it provided good courses, and that it was not a function of a university to "hawk its wares about."

Registrar

Apparently the duties of the registrar can be broadened with far-reaching results. In the first place registration of all kinds should be centralized in the registrar's office. This is now done in many universities. But even where the registrar registers, he does not follow up in any way. His records show the maximum registration, which is usually far beyond the actual at any one time. If fuller information about the individual student is desired, it will probably come about primarily through greater care in keeping the registrar's records.

It is rather unusual to find a college teacher whose administrative experience and opinions extend measurably beyond the limits of his own immediate courses and specialty. This is as true inside the various departments of physics as it is in the institutions generally. If there is this absence of accurate knowledge in regard to courses inside of a single department, it is obvious that under present conditions it is practically impossible for any one person, or any group of persons, to have the knowledge necessary to plan the work of any one department so as to complement the work of other departments, in the matter of hours, rooms, teachers, etc. As long as this is the case, the methods used in laying out college courses must in large measure be unsatisfactory.

The difficulty, in some cases, with room schedules and course schedules, and the apparent conflicts which were found in them, together with the obvious difficulty of arranging classes, sections and courses with the machinery at present available, led me to make some inquiries among recent graduates. I was told that for the first month after college opens mistakes in rooms, assignments of teachers, sizes of sections, etc., are constantly cropping up. I do not see how it could be otherwise.

Williams College has a recorder, who keeps a record of the number of students taking the various courses, the number of "student-hours" [1] (based on the scholastic weight which obtains there, *i.e.*, two laboratory hours equal to one recitation hour, etc.) in each course, and once a year, as a part of the dean's report, he makes an in-

[1] This term as used here has not the same meaning as the student-hour explained on page 19.

teresting statement showing the relative amount of work taken in each department. This report is framed in such a way as to make the figures easily comparable with those of previous years. This work might be made a part of the duties of the registrar.

In the hands of the registrar might be placed the question of the economical use of buildings. And if he is to use the buildings to advantage, in his hands will probably be left the greater part of the planning as to the hours of the day when courses are to be given. Here is certainly large room for improvement. I found at Williams an instructor putting in three hours a week extra in the laboratory on account of one student who otherwise would have been unable to take the course. The conditions seemed to indicate that a minimum of interdepartmental planning and coöperation would have avoided this.

Under the elective system the necessity for a scientific and detailed study of this whole matter of hours is becoming every day more noticeable. Apparently much may be done to minimize the more or less foolish considerations on which electives are chosen. Everywhere, with one exception, it was admitted that courses are so chosen. A course in which the exercises occur in the middle of the afternoon or the first hour on Monday morning is very unpopular with the students. Many courses are popular because it is the custom to take them, or because they are considered easy —called "snap courses;" still others, because they have just the number of hours to fill out a required schedule. There are other reasons of the same general character. I am sure that without changing human nature these various considerations could be largely eliminated in the choosing of courses. One plan suggested is to have a required course of lectures to the second term freshmen, in which the various possible careers would be outlined. The strong and weak points of a doctor's or lawyer's career, of an engineering or business vocation, etc., could be discussed in these lectures, and the application of the various courses offered to each of these lines of activity pointed out. As a result of this and other measures, and without in any way curtailing the elective principle, the students would be led to map out their courses more consistently, and if so mapped out, the courses could be more easily handled.

Bureau of Inspection

In most lines of human endeavor there has been experienced the necessity for a branch of the service which shall have to do with passing on the quality of the work. And I believe that in the colleges we must have a similar inspecting agency. At one place I found a departmental inspection service in force. It was crude, and I do not think it was recognized exactly as an inspection service. But it was the policy of the professor in charge to arrange to visit the various sections in his department and to remain throughout the hour period. He used this means of keeping himself informed concerning the class-room methods of the men in the department and to be in a position intelligently to suggest improvements. There are few men, however, who are endowed with the force and energy necessary to maintain a system of this kind

in the face of the natural obstacles. This is not one of the things expected of a professor in charge of a department, and naturally it will be one of the first to be sacrificed under pressure of other and seemingly more important duties.

To be done well, the inspection service should be a specially designed agency. I think it would be comparatively easy to train one or more men to be specially helpful to their associates in teaching methods. I am sure that if such a system were in force, it would bring to the attention of those in authority—before they had a chance to do much harm—conditions which ordinarily run throughout the school year and thus do large damage. Such a bureau as this would quickly develop special means of scenting sources of trouble and inefficiency. If the records as to absences and class-room discipline were to be filed with the bureau of inspection, one good danger signal would be afforded.

It is not impossible that the work of a bureau of inspection may suggest the necessity of an agency—especially in the larger institutions—for training teachers. At the present time most assistants are recent graduates without either the teaching, training or experience with the world which might help them in their relations with students. One would think that if in the industrial world it is considered essential to give a man some drill before he is allowed to sell books or a cash register, considerable good might be anticipated from a little coaching in class-room methods. Every one who has attended college knows some of the things not to do. Perhaps, if these could be grouped and a few affirmations added, it would make the basis of a profitable course for those beginning collegiate teaching.

In the same way, it might be a part of the duty of this bureau to keep correlated the record—scholastic and otherwise—of each individual scholar for the purpose of providing special treatment for those who require it. Under existing conditions there does not appear to be enough effort to group all the available information about the progress of any student. Teachers in any one department may know what a given student is doing for them, but to find out what he is doing elsewhere is attended by so many difficulties that the effort is made only in extreme cases, and then only after the student has been long in trouble.

It seems to me that every institution visited was holding off from establishing this kind of individual relations with the students for fear of the expense involved. The argument seemed to be that to do this work effectively would at the beginning require a large corps of preceptors. I believe that, with some scheme of getting quick returns on the character of work being done by each individual student in the various departments, even a few preceptors, representing the bureau of inspection, and following up intelligently the students furthest in arrears, would bring up the character of work done by the whole student body. In the industrial world it is being found out that rewards and disciplinary measures must follow quickly the act for which they are meted out if they are to have the maximum effect. Therefore I believe that it will pay in the college world not to permit all the pressure on students to

be piled up at the end of the term, when it is frequently too late to be of any avail.

In an industrial enterprise the inspector has little to do when things are going smoothly, but he is indispensable nevertheless. And when things are going wrong everybody is delighted to have a specialist around. And it usually happens that the amount of spoiled work is at a minimum in those establishments which have the best ordered inspection corps.

It may turn out that ultimately the matter of examinations will be handled by an agency outside of the department. Should the college world work around to the idea that a high percentage of failures is as apt to be the fault of the teachers (and those employed to look after the students outside of lectures, recitations and laboratories) as of the student body, it may be well to divorce the teaching and examining functions. It is axiomatic in the industrial world that inspection, to amount to anything, must be performed by some one else than the person who did the work. The college men are awake to the advantages of such a system, but they feel that the disadvantages would far outweigh them. They believe that teaching would develop into a system of coaching to pass examinations, if one arm of the service examined and another taught. It is not clear to the layman why sufficient safeguards could not be thrown around both teaching and examining methods to invalidate this argument. Nevertheless it is held by most of those with whom I talked about it that this is the relation now existing between preparatory school teaching and college entrance examinations.

Other functions than those suggested may well be developed for such a bureau of inspection. For instance, such a bureau might make a specialty of studying the failures and classifying the causes. It is hardly possible that any systematic study of such data would not lead to material changes in our scholastic methods. In the records and lists of our highly organized alumni associations there is afforded a mass of valuable data which should be studied by some one with care. If a given school is seeking to turn out well-trained mechanical engineers and has hundreds of her sons already in the field, every effort should be made to use them as an agency by which the future product can be constantly improved. The manufacturers of one of the best known typesetting machines follow every individual machine from the time it is sold until it is "scrapped." A running record of its break-downs and its performance is kept. This is not done for the sake of the machine, but because only in this way can the future machines be made so that they will not be subject to the same faults.

In an industrial establishment the inspectors are just as much interested in the raw material as they are in the finished product. It is largely on the suggestion of the inspectors that the purchasing department keeps changing its specifications so that the materials purchased more and more fully meet the uses for which they are required. In the same way it will be the function of our collegiate bureau of inspection to study the raw material—the students coming in from the secondary schools

—and to suggest the lines along which it might be improved. The president of a western university recently told me that there was no difficulty in getting his students to work—if anything, they worked too hard. He pointed out other weaknesses, which, considering them as raw material, they certainly possessed. He had instituted far-reaching and far-sighted steps in order to correct these faults. At another institution visited, it was reported to me that necessary increase in the amount of work demanded of the students had been instituted with the utmost difficulty. Each slight raise in standard had been attended by a large increase in the number of students dropping out. The preparation of this raw material evidently had not left a sufficient margin of safety. So it would appear that there is room for intelligently and properly organized inspection both of the college's finished product and of its raw material.

As standards are adopted among the colleges, it is going to be more and more necessary to have in each college an agency whose special function it will be to see that such standards are in force there. This is another duty which might be assigned to the bureau of inspection.

THE position that I have taken in going over these institutions is that they exist primarily for their teaching departments, such as the department of astronomy, the department of Greek, the department of economics, etc. I use this term department as it would be used in an industrial sense and without regard to its *personnel* or the quarters it occupies. Here the word teaching comprehends all the work done by the departmental staff, whether in direct instruction or in research. Broadly speaking, the teaching departments in a college or university are the equivalent of the manufacturing departments in an industrial enterprise. To each one should be charged up its own direct expense and its proportionate share of all the overhead expenses. On this plan the total annual expense of the institution should be divided eventually among the teaching departments. Only in this way can there be secured the total cost of teaching in any department and this cost in turn compared with the product.

There are a number of different items which together constitute the total expense of teaching in any one department. For instance, in nearly every institution the salary item for each department is considered by itself even if it does not so appear on the books. Whenever additional salary is wanted in a department, it is the routine procedure to inquire first what is the present salary list. Expenditure for equipment and supplies is another item of the total expense that is usually isolated for each department and watched pretty closely. In most institutions, before expenditures under this head are made, there must have been an appropriation to cover the amount of it. At Wisconsin I found a complete budget system. The expenditures for salaries, equipment and supplies, etc., for each department, were determined in advance by means of a budget, and efficient safeguards were erected to prevent the expenditures going beyond these predetermined figures. But even at this institution only a part of the items of expense were so segregated, department by department. No substantial progress will be made in controlling the expense of university work until the whole expense is definitely known, and this expense is divided with fair accuracy among the several departments. The educator can then adopt some measure for the output of each department—crude, though, at the start such measure will doubtless be—and he will know the approximate amount the product is costing, and why. As soon as a system of this kind is adopted, the beginnings will have been made of installing efficiency as the test in college management.

Included in the idea that a university is operated for its teaching departments is the corollary that such features of the general collegiate life as the library, the chapel and the gymnasium are operated only because they assist in the teaching work. Every item of expense involved in maintaining each one should be charged up against it, and against this charge should be set off the current revenue which it brings in, in order to secure the net expense of operation. It is suggested that all overhead expenses be pro-rated to the various teaching departments in the proportion of their

teaching salaries. This will be following the industrial practice of charging overhead expenses to the various manufacturing departments in proportion to the wages paid in those departments.

The dormitories under usual conditions will be in a different class from the library and gymnasium, because as ordinarily operated they are considered as investments, and therefore revenue producers. There may be conditions under which this viewpoint will have to be modified somewhat, but generally speaking, a university or college owning dormitories should operate them so as to be able to determine at the end of the year the net income from them. There will then be only in very rare cases any charge against teaching on account of the dormitories; even when they may not be run so as to earn a high—or in fact any—rate of interest on the investment, they will at least pay operating expenses. When there is any excess of expense over revenue on their account, however, it should be a charge against the teaching departments. Such a charge is more likely to occur in the case of the college commons, which seems to be much more difficult to operate at a sufficiently high level in point of service and yet yield a profit. The amount of earnings will be, for both dormitories and commons, one important measure of their efficiency. When they are made to pay their own way in the matter of expense and income, other definite measures of efficiency covering the quality of service given will doubtless be available.

In the same way, each of the other incidental features of university life, such as the library, gymnasium, etc., should be treated as an entity, the net expense of which should ultimately be pro-rated among the teaching departments. For each such feature some means should be provided for measuring its product. In the case of a library, for instance, arrangements could be made for securing a tally on the number of persons using the library, the number of books called for, the number of books bought, etc. Some index should be provided to measure every line of the library's activity. The time seems to have gone by when we can afford to maintain features which are not definitely useful and in which their usefulness does not bear the proper relation to their expense. If we know the total cost of each, and then make some effort to measure the product, it will be possible to decide whether the product seems to warrant the expense. If every university would do this, each could decide, by a comparison with the experience of the others, how efficiently its own departments are being operated. It is desirable to have a library, but we want to be sure that a library which is costing ten times what another costs is doing "work" in proportion.

It may be well to repeat here something I said earlier in this report; otherwise, the cry of Philistinism may be raised. The old idea was that a university was made up of so many departments, *i.e.*, a library, a chapel, a Greek department, and one covering natural science, for instance. The existence of any one of these departments was in no way contingent on its measure of usefulness. The thought of abandoning such a department or curtailing its expenditures beyond a certain point was unthink-

able. In our American colleges this is apparently no longer true. Everywhere I went I found the question of functional efficiency being raised among the responsible heads of the institutions and the departments. Men are anxiously seeking the ways and means of measuring the "usefulness" of this and that line of endeavor or expense. But coupled with this, in most cases, there is a desire to interpret "usefulness" in that broad sense which puts a true value on those more or less intangible elements in college life which tend toward the development of the things of the spirit. I cannot impress sufficiently upon those who may be tempted to raise the cry of Philistinism, that while a practical attitude has to be taken in reviewing each activity herein studied, it is not at all with the idea of attaining simply a commercial type of economy that suggestions as to changes are made. In the last analysis the "usefulness" of a university is the measure of its mental, moral and spiritual product—and product interpreted as broadly as you please. But it is only logical to analyze carefully all the different activities which are supposed to work individually and collectively toward this end, if we are to judge intelligently of how adequately the mission is being fulfilled in comparison with the time, effort and money expended thereon. And the ultimate object of such study is not to condemn or even to criticise, but to build up such an array of facts and figures, and such deductions therefrom, as may help not only toward maintaining, but toward increasing that very atmosphere and spirit which are admittedly so essential to the true college and university life. Surely ardent idealists will not contend that the fullest influence of a university is made impossible by a thorough understanding of each of the practical problems involved.

Under this interpretation a library may "pay" if only half a dozen students enter each day. Its principal function may be to house books which for the most part are not in frequent demand. It may have no reading-room function to perform. But whatever its function, there certainly can be no harm in defining it as closely as possible and then attempting to say how well it fulfils this function. In the same way, it may be held that a given university must be prepared to teach a certain dead language even if there are no students who wish to study it. This would be consistent with our idea of university efficiency and usefulness. In other words, a policy which would maintain a Sanskrit department over a given period of time, in the absence of students, might "pay" in a university sense. One would expect the cost per student-hour in such departments to be very high, but surely we ought to know how high it is. It will "pay" the university and the world to protect some branches of learning in the face of extreme indifference on the part of the student body.

The policy of charging to each department its share of the expenses of the non-teaching features will make everybody connected with the institution interested in its management. If, in a certain sense, they are helping to pay the bills, the departments through their representatives will be more watchful of the methods under which the money is spent.

It would seem best to charge all the expenses of a building up to the building, and then twice a year (*i.e.*, once a term) pro-rate this expense against the departments using the building in the proportion in which they use it. The adoption of this policy will result in there being many rooms not claimed by or occupied by any department. The expense of this space should be pro-rated against all the departments. This in turn will have the effect of getting the coöperation of everybody in keeping this amount of unused space as low as possible. The keeping of the expense of maintaining and operating a building separate will mean that such items as gas, water, electricity, etc., will generally have to be metered for each building. This is done now at some of the universities. Where there is a central heating plant, the charges will be on the basis of so much a square foot for those parts of the building in use.

Administrative expenses, such as the salary of a president who does no teaching, will also be pro-rated among the departments. But many so-called administrative expenses can be immediately charged direct to a department. For instance, at Harvard University the expense of printing the catalogue is now largely charged direct to the departments in proportion to the number of pages occupied. This has the effect of making the departments take more interest in the matter which goes into the catalogue.

In my opinion, nothing can be done which will have a greater or more immediate effect in minimizing departmental autonomy than keeping a close watch on departmental expenses. It will quickly establish the fact that everywhere there must be some relation between expense and the amount of work done. It will weaken the hold of the departments on their buildings, and will make everyone interested as they never have been before in the overhead expenses of the plant. And at most institutions this can be done by the present accounting staff at no increase in cost.

It would appear that if expenses are to be segregated in this way, department by department, earnings should be handled in the same way. In other words, tuition fees should be pro-rated to the various departments in proportion to the amount of tuition furnished. In the same way, if special fees are charged, as is sometimes the case in laboratory work, the department receiving them should be given credit for this amount of "earnings." In this way the gross and net expenses of each department can be figured out. If this is done, it will probably result in a material readjustment of the scale of charges now in force. At the present time no effort is made to show from time to time the amount of fees "earned" in the different departments. In some cases, the fact that a department does earn fees is given as the excuse for being more liberal with it in the matter of appropriations. But as a general thing the fees in bulk are considered as one form of revenue. It would seem as if they should be made to stand clear of interest on endowment funds or gifts.

A statement of receipts and expenses, department by department, based on the foregoing, would be, as far as the writer was able to ascertain, a new departure. That it would be of large value in interdepartmental and intercollegiate comparisons seems certain.

The statement of gross expenses, department by department, would be of much greater use if the registrar's records could be kept in such a way as to show the number of student-hours per year in each department. If all registration for courses were made at the registrar's office (as is now done at some institutions), and his records were designed for the purpose, these data could be obtained with little extra labor.

Given the number of student-hours in every department and the total cost of operating every department, the cost per student-hour in each department can be ascertained. These costs will be in such shape that they can be analyzed. The total cost per student-hour can be subdivided into as many parts as necessary in order to discover the reasons for interesting variations. (See Table 10, Part 2.) In the best of the cost analysis tables now being furnished at the colleges it is impossible to find out, except in the broadest way, the reasons for the variations in cost.

Observe, for instance, this table from the Report of the Treasurer of Yale University for the year ending June 30, 1908, as given in *Science* for May 14, 1909:

Expenditure and Receipts per Student in Various Departments of Yale University, for the Year 1907–8

Department	*No. of students*	*Expense per student*	*Receipts per student*	*Ratio Receipts Expense*
Graduate	357	$159.45	$ 40.17	25.2 per cent
Academic	1315	339.56	152.27	44.8 per cent
Sheffield Scientific	948	279.66	160.25	57.3 per cent
Theology	80	641.03		00.0 per cent
Law	339	177.14	122.86	69.3 per cent
Medicine	137	396.90	130.22	32.9 per cent
Art	39	315.02	69.25	21.9 per cent
Music	83	268.99	140.12	52.1 per cent
Forestry	61	469.39	119.17	25.3 per cent
All Departments	3359	296.85	113.25	44.9 per cent

The units used here are all too large. They include too many variables to give helpful data. An expense analysis on the basis of student-hours removes the large cause of variation brought about by the different numbers of hours in different courses, and makes it possible to separate those items of expense which should be the same for all departments from those which would necessarily vary in the different departments.

Among the hospitals the unit in figuring costs in general use is the patient-day. This cost of keeping one patient one day is in turn divided up into such items as food, nursing, medicines, etc. This makes it possible to compare profitably the expense of keeping a patient in one of the free wards with the expense of keeping another patient in a pay ward. Some of the items of such expense are exactly the same in each case, while others, such as nursing and food, may be quite different in the two cases.

It is probable that after such a method of keeping costs has been in effect for a time, there will be established for each of the great departments, such as languages, law, music, engineering, etc., an average expense per student-hour. It will then be possible for each institution to decide how much above this average expense it may, on account of peculiar local conditions, be warranted in going. It will undoubtedly follow that certain institutions will drop certain lines of work which are done at too high a relative expense. It might easily result that two or more institutions close together, and each offering, sparsely attended, special courses with high student-hour expenses, would agree to distribute the work in such a way that any one institution would do only a part of it.

After an adequate classification of accounts has been prepared, the actual bookkeeping involved will be simple. Many of the charges will have to be made only twice a year. In fact, it will be easy to keep for each department separate expenses on each of the courses given. Hardly anyone will deny that data of this kind would be of great assistance. On Tables 9 and 10, Part 2, I have given specimens of reports on teaching and expenses in the form in which I think it will pay to publish them in the annual reports.

After these records have been kept for some time, it will probably be possible for each university to appoint any departmental staff on the basis of the number of student-hours. As has been pointed out by the Foundation, with $15,000 or $20,000 to put into salaries in a given department, it is hard to decide how many teachers of each salary grade it is best to employ. It may be possible, with student-hours as a basis, to say, for instance, that in a department giving annually 85,000 student-hours in physics, the department is entitled to one professor at $5000, two assistant professors at $3000 each, four instructors at $1500 to $1800 each, and six assistants at $500 to $800 each.

It may also be suggested that the student-hour might be used as the basis on which to differentiate institutions calling themselves universities and colleges. It will be possible, after each department and each course in each department is put on the basis of student-hours, to classify institutions according to the number of student-hours given to subjects respectively of college and of high school grade. By this method, a so-called college with thousands of students studying bookkeeping and arithmetic would not be placed in the college class.

Under this plan there would be afforded a special incentive for preserving a reasonable relation between the number of courses offered in the catalogue and the number of students registered for each course. A wide offering of courses would not in itself entitle an institution to college or to university standing.

This matter of costs has been largely confused in collegiate accounting with the entirely different matter of the analysis of revenue. There is plenty of reason for believing that the desire to be over-careful in the matter of accounting for funds of all kinds has led our collegiate financiers to overlook the question of cost.

In the Appendix, Exhibit B, will be found certain extracts from the Report of the Treasurer of Harvard University. These extracts constitute the only references in his report to the department of physics or to the physical laboratory. A casual reading of the table of receipts and payments (page 121) would indicate that the total expense of the physics department amounted to $8,999.93. Further study would probably suggest that salaries for teachers could not be included in this, especially if one happens to know that there are thirteen teachers, and of these, four at least receive salaries of $5000 a year or more. No amount of study would show, however, that this department received and expended over $5000 in fees which do not appear except in a grand total on the treasurer's books. In fact, the more closely these "detailed" reports of the Harvard treasurer are studied, the less one would expect to find that the total direct expense of the department of physics amounts to over $47,000. I was able to locate payments amounting to this figure. But this does not include all. As a responsible and competent accounting authority of the institution wrote me, "There are very considerable expenses of research which are not reported to the treasurer, because they are paid from trust funds held outside of the university and also from private sources."

It is undoubtedly bad practice for a university to allow moneys to be spent in any department when such moneys do not pass through the treasurer's books. I can find no analogy for this in industrial or other undertakings. I am sure, that even if such a thing were possible, it would be considered a menace to permit it. Could a hospital, for instance, long maintain its organization, with money regularly being spent in its various departments and not subject in any way to the general hospital control? Such moneys can be turned over to the university authorities under any desired degree of anonymity and under any number of restrictions as to their use, but in the long run it will be found to make for efficiency to have all such moneys follow the usual course and pass through the treasurer's books.

Too much weight is everywhere given to the origin of the money used for any given purpose. In collegiate finance, one dollar does not seem to be quite as good as another dollar. In the Report of the Treasurer of Harvard University (Appendix, Exhibit B) is given a list of the various items of income for the physical laboratory. No reference is made to the matter of students' fees, which are turned over to the laboratory. This omission is not excused, but accounted for by the fact that all strictly departmental fees have been considered as subject to disbursement by the department earning them and virtually without an accounting.

On the expenditure side of the same report, one item of nearly $3000, and two others of approximately $500 each, are given as the income of certain funds. There is no word as to what was done with these moneys; while below occurs the entry, "Supplies, sundries, $5.81." The interpretation of this appears to be that moneys which are left for a given purpose are not spent under the same degree of supervision as are moneys which can be used for one of several purposes. When moneys are voted

for a given purpose out of general funds, there seems to be a greater desire on the part of those expending them to justify the appropriation by saying just what was done with it. Further appropriations may depend on this being done. On the other hand, when the moneys can be spent only for one thing, the minimum of an accounting is forthcoming. The item of $5.81 above was spent out of moneys provided for the use of the laboratory out of the general funds of the university. Hence, the list of disbursements of which it was one was printed in detail.

The total revenue at the disposal of this laboratory was made up (1) of interest on funds which had been left for its specific and exclusive use; (2) of fees from students in the department; and (3) of moneys voted from the general funds of the institution. The fees were ignored in all the printed reports of the financial operations of the laboratory; the amount, but not the disposition, of the income of trust funds was given; and of the moneys voted out of the general funds, only a relatively small part is mentioned in the tables, but the disposition of this part is given in great detail. Considering the omissions, this is only misleading.

This report is picked out for illustrative purposes, not because it is unique among collegiate financial reports, but because it illustrates some of the weak points in most of them.

It would appear to be bad practice to allow the departments to make any difference as between moneys. The origin of money may have a place in the budget, but from that point on it would appear that one dollar should be disbursed under the same amount of supervision as any other. Surely, if any difference is to be made, it would be to throw every safeguard around that which has been made available by the generosity of some friend of the institution perhaps long since passed away. The present system does not do this. Under this system, the more careful a benefactor may have been to specify the use to which his money was to be devoted, the greater the opportunity for a portion of it to be spent without results.

The departments should be made to develop the probable profitableness of a given appropriation, where there is a specific fund to be used for a specific purpose, in just the same way as they now have to do when there is no such fund. It might easily occur that in any given year it might not be wise to make *any* expenditure from such an income. The feeling seems too prevalent that the interest on money left for a given purpose must be spent as it accrues, rather than that it should be spent along the lines stipulated by the donor but reserved to a time when it can be done with efficiency.

The expense statements should not be mixed up with the income reports. The analysis of revenue can be better accomplished by publishing in the reports and tables many of the details which are now omitted. The importance of an income statement, with the fullest possible analysis of the sources of revenue, to those operating these institutions, is recognized, but it should not be confused with other things. This combining of income and expense statements is done in such a way at times as to

be positively misleading, without, of course, any desire to produce this effect being present.

As a general rule, I believe it will be found inexpedient to have any financial transactions between departments, or between individuals in a department, or between a department and an interest outside the institution, without having such transactions conducted under the instructions of the treasurer or other financial authority. I believe such a rule is not now generally observed. For instance, I found one man carried on the roll of Columbia University as a teacher, and reported to the Foundation as having duties, but as receiving no salary. He is taking "half the duties" of one of the other members of the staff, because the latter is devoting much of his time to commercial experimentations. For this he is paid directly by the man he is relieving one-half the salary the latter receives. The authorities are fully aware of the arrangement, of course. But it is of a class of "understandings" which are considered dangerous in business.

Everybody interviewed claimed that the frequent publication of the names of donors was profitable. The special value of large type, in printing these names, used by Harvard was pointed out. If this is true, there would appear to be many improvements that might be brought about in presenting the matters in connection with these funds in a way more intelligible to the ordinary reader of college reports, and therefore in a way better designed to encourage further donations.

There is the greatest difference in the matter of computing the income on trust funds. At Harvard, for instance, broadly speaking, all moneys given the institution for any purpose are invested according to the best light at the time the investment is made. No effort is made to keep this particular investment separate from the others. The amount of it, of course, is recorded, and at the end of each year the income on it is figured at the average interest on all invested funds. If this income is not all used, the amount of the principal is increased by the amount of the surplus. This would appear to be one good method of handling a large number of separate funds.

At Princeton University every effort is made to keep every gift and bequest absolutely separate from every other. Thus, if A gives $1000, the interest on which is to be used for botanical research, a bond may be bought for $995. The interest on this bond will each year be used for the purpose mentioned. The remaining five dollars will be deposited in a separate account in bank, and twice a year interest will be computed on it, not at any general rate for all similar funds, but at the particular rate obtaining on the account where deposited. This interest thus being added to the five dollars twice a year will be allowed to accumulate until the amount in hand is enough to buy a share of stock or some other separate asset. Under no circumstances are two or more funds pooled and their joint interest divided in proportion to their respective interests. Between these two extremes in method there are doubtless many others. Surely this is a matter where there should be some standard practice which all could follow to advantage.

Any plan adopted must necessarily start in with the assumption that the wishes of a testator will in every case be absolutely respected. But it seems likely, if a common sense plan were adopted and generally known, that those giving money would as a rule prefer to give it so that it could be handled as other funds are handled rather than on some exceptional basis.

Nearly all college financial reports give too many details and too little information. For instance, the reports of all the state institutions practically list the individual vouchers. This may have a value in preventing suspicion of corruption, but unless amplified by further statements showing the operations of the university in larger amounts, it has little accounting value. Perhaps the weakest point in these financial publications is that the makers of them seem to think that the publication of a large number of details taken off the books makes up for the lack of those larger statements such as one finds, for instance, in the reports of railroad companies. There are many classes of entries which must have a place in bookkeeping, but which have no proper place in financial statements. They not only do not elucidate the tables and reports; they have positively a bad effect in that they make it, as in the Treasurer's Report of Harvard University, almost impossible to understand anything without a more intimate knowledge of local conditions, which it should not be necessary to have in order to interpret annual reports.

There are a number of matters connected with accounting which could be standardized by some association of educational institutions better than by the individual colleges themselves. The viewpoint and conditions at any one college as to some matters are necessarily too limited to make it possible to frame a procedure under which all can act. In the matter of the valuation of lands for the purposes of the balance sheet, Princeton might adopt what would seem to be an excellent plan for her, but it would have no significance for the Massachusetts Institute of Technology. Yet if one is to be able to compare their balance sheets intelligently, the rule under which each should work should be broad enough to include both. I think that the absence of such a standardized practice is one of the reasons why these institutions have avoided balance sheets.

Again, each school defines "repairs" and "construction" according to its own light, and the definition is largely an accident. This is a vital matter because on this definition depends whether a given expenditure shall be considered as adding to the current expenses of a given year, or whether it shall increase the monetary value of the plant. A good rule seems to be: "Money paid out should not be reckoned as an asset. If paid for property that is on hand, the property is an asset. If expended in a way that has enhanced the value of the general assets, it is included in the general valuation. If so expended as to have brought no property and no enhancement of that on hand, then it is a loss, and should not be counted as an asset" (79 Iowa Reports, 678).

Partly on account of collateral considerations, I think it will pay the universities to

carry their buildings and grounds on balance sheets at their "true values" as nearly as these can be determined. It is necessary to set this value on most buildings for insurance purposes. It will probably not be found necessary to change these valuations more often than, say, once every five years. In the meantime, only specific charges for new constructions would be made. If the grounds and buildings are so carried, the methods of valuation and the periods for revaluation should be definitely determined and not left to chance.

In the early days of accounting its function was largely "that of keeping account of claims and property in order to secure the concern against the loss which might arise from forgetfulness, carelessness or dishonesty. This phase of accounting attains its acme in governmental accounting, where the essential thing is to insure the proper handling of vast sums."[1] And this is the function of accounting which up to the present has almost exclusively interested our college accountants. But in the industrial world this has long since become the least important function of accounting. The real essence of accounting is found in its ability to give a correct and complete exhibit of the financial status of the concern at any given moment of time by means of a proper balance sheet; and secondly, a showing of results obtained during any given period of time by means of (1) income, (2) receipts and expenditures, and (3) cost statements. The colleges are only beginning to develop this function of accounting.

[1] *Modern Accounting*, by H. R. Harfield. Appleton, 1909.

PHYSICS DEPARTMENTAL ADMINISTRATION

In the physics department, as I suppose in all other departments, there are questions of administration which are peculiar to it. In the handling of apparatus, for instance, there is the largest opportunity for waste. Some universities seem, more or less unconsciously perhaps, to hold apparatus long after it has ceased to have any pedagogical or research value. It is a constant source of expense, both in taking up room and in requiring a certain amount of care. The proper policy here would seem to be so different from the current practice as to be out of the question until the various laboratories have passed through a period in which they will have at least made the attempt to have proper storerooms and house their apparatus in such a way that it lends itself to easy inventory and proper maintenance.

As some of the functions now exercised by individual departments are taken over by the university management, it is possible that the museums and the maintenance of apparatus will come under one head. If, as seems likely, more attention is going to be paid to the care of such apparatus, some central management is going to be necessary; and I should think that the professors would welcome it. The idea that nobody but a professor of physics can inventory a piece of physical apparatus, or that nobody but a specially trained physics laboratory attendant can dust a microscope or oil a tuning-fork will then be dispelled. In some places a great deal of time seems to be lost in the matter of mixing apparatus used for lecture purposes and for laboratory work. I think this is more apt to occur in those institutions where undergraduates are put on research work of their own, *i.e.*, where individual students require apparatus not used by other men. It would seem to be a good practice to have one set of apparatus for lectures and another for undergraduate laboratory work, and that it all should be kept in a high state of repair, and be disposed of as soon as it becomes obsolete. There is a theory that no apparatus should ever be thrown away, that it always has a "junk value" for rigging up new machines, etc. I believe there is nothing in industrial practice that would warrant this assumption.

In some places it seems to be considered necessary to have an apparatus room immediately adjacent to the lecture room where the apparatus is generally used. I would question this practice, because the apparatus is as a rule used only once a year, and the number of pieces required for any one lecture is small. It would seem better to carry this up a couple of flights, in the absence of an elevator, rather than to make thousands of students during the course of a year walk these extra flights in order to get to a recitation room.

In almost every place I visited there was more or less expensive apparatus bought for research work without prospect of further use at the university where it was located. If some such organization as the Carnegie Institution or the American Physical Society could keep an inventory of the larger items of physics apparatus at the different universities, it might result in some borrowing, and in students of one uni-

versity going to another to carry on some particular piece of research. I saw one machine tool, for instance, that cost $2000, which I was informed would not be used again at the university where it was stored because the particular piece of research for which it had been bought was concluded.

It has already been suggested that a further development may be expected in the matter of laboratory attendance. Along just what lines this development will take place it is impossible to say, but there is no doubt that many expensive, highly competent men are now spending too much of their time doing things that might be done for them (perhaps even better than by themselves) by low-priced laboratory assistants.

Too much importance cannot be given, I think, to the order which obtained throughout the laboratory at the University of Toronto. I never have seen an industrial or commercial plant of any kind maintained in as good style. The floors were clear, and in every instance the tables showed that the man who had last worked at them had made the condition in which he left them a matter of some thought. The apparatus, as it was placed in the cabinets, was put away in such a manner in the assigned places that any one familiar with the system could locate it. Especially I want to call attention to the condition of the research rooms in this laboratory. At every other place they were not conducted in such a way as to give the largest measure of efficiency, judged from an industrial standpoint. There is a tradition that Rayleigh, Kelvin, and some other distinguished physicists do good work under conditions of the utmost disorder; and without, of course, attempting to imitate them, there seemed to be a feeling that good work was not inconsistent with disorder. The research rooms at the University of Toronto could not have been kept in better order, and an inquiry made at every place I went indicated that the scientific results of the work done in this laboratory were of a superior character.

The matter of operating the library in the physics building again shows the widest difference in practice. At two places the library of the physics department had no connection with the library of the university. At another there was a separate physics library maintained, which was supplemented from time to time by borrowings from the central library; and at another the physics library was made up altogether of books sent over from the central library. These were replaced from time to time as other books were obtained, or as the courses being taught seemed to make other books desirable.

In the matter of so-called inbreeding, again, there was the widest divergence. Most of the colleges visited, however, seemed not only to desire to have men from other schools, but actually had them. Among eight institutions perhaps only one, the Massachusetts Institute of Technology, might be subjected to criticism for the fact that of seventeen teachers in the department of physics all had been undergraduates at the institution at which they taught. Statistics in regard to this matter will be found on Table 2, lower section.

It was interesting to note the ideas of the different schools as to what they thought physics did for the students. Of course in this inquiry we had in mind only those students who took physics simply as a part of their general education, without any idea either of teaching physics or of doing research work. No two colleges gave the same reason. There is hardly any doubt that the value of physics as a cultural study is not generally appreciated by the men who are teaching physics. In other words, they are teaching physics for physics' sake and not because of any broad application which physics may have to the life of the student. Perhaps the best reason that I obtained was that it was valuable in any broad scheme of education to have one science taught as an illustration of the inductive method of modern science, and that as physics was less dependent upon the gathering of data, it afforded the best example of this. Another able teacher said that he considered for the average student the chief importance of physics lay in the value which attached to the precision required in making measurements. Another thought that it taught pupils to observe *all* the phenomena connected with a given event. Another thought that it absolutely failed in producing this result. Still another frankly admitted that he had never given the matter any special thought.

Physics is undoubtedly a specialty, and I was interested to see what effort was being made to give it a broadening value. Here, too, I found all the extremes, from one institution where the professor felt that unless a person was interested in physics he did not care to make him so, to another where constant efforts were being made not only to emphasize the broad cultural value of physics to the student taking the course, but to make the entire university feel that the department of physics was one of the most interesting places on the campus, and one that must be safeguarded at all hazards. In carrying out this policy at the University of Toronto, there were lectures given during the year on such broad questions as measurements, energy, the theory of matter, etc., the entire university being invited to attend. The subjects were so treated, of course, that one not especially familiar with physics could comprehend them. It might give an erroneous idea of this work if I failed to add that there was not an excess of this kind of lecturing. It was not done with any idea of making physics easy, but to give physics a standing as a cultural study which it would not otherwise have possessed. It would seem that if in other branches this same effort were made to combine with the highly specialized treatment the expression of a broad application, learning as such would be much better understood in the community.

STUDENT ADMINISTRATION

On a recent visit to Columbia University, not connected with this investigation, the writer saw the students gathering for a mid-day class, and was impressed with the fact that almost without exception they walked leisurely toward the building in which the class was to be held, seemed to have time for campus talks with those they met, and in nearly every case were smoking cigarettes. Having occasion, a few moments later, to enter this building, he discovered this class holding a debate under almost riotous conditions. The debate was one I had frequently participated in fifteen years before when at college, and it was over the question as to whether it was etiquette to wait five or fifteen minutes for a tardy professor. This class finally waited about fifteen minutes and then dismissed themselves without hearing from the professor. To show that this is generally a mooted question, the dean of another university excused himself for terminating an interview rather hastily, because, he said, his students felt that a college professor should be allowed only a short margin in meeting his classes. The point is that there should be a definite rule, understood both by the teaching staff and the students, as to the grace to be allowed. It is difficult to see why even this should be necessary. The moral effect on the student would be better if a professor who has a class at ten o'clock should dismiss his previous class a few moments before the close of the period, in order to permit him to be punctually at his post. It seems to the writer that a great deal will have to be done in bringing college boys to a realization of the necessity for a more intensive application to their work during that part of the college day when they are supposed to be engaged in serious pursuits.

In this connection may be cited the question of absences. At one institution visited, the students are allowed thirty so-called "cuts" a term, *i.e.*, absences for which they are not required to give any excuse. This is the preparation afforded for a life which begins the moment college closes, where one "cut" brings a serious reprimand, and two will probably lose a position. At thirty cuts a term, the student would be entitled to two hundred and forty in a four-year course. The fact is that in many instances the cuts allowed are unnecessary. The dean of one college told me that students did not settle down to their best work until their cuts were all used up. As long as they had these cuts ahead of them, they seemed disconcerted. In almost every instance every cut allowed was used. The writer had a companionable classmate who, simply for the interest of making the experiment, went through a college course without absences of any kind. In any study of efficiency this question of absences certainly will have a place.

Just as I have recommended that a special study must be made of increasing the individual efficiency of the teachers, I feel that more effort must be put into the study of the efficiency of the undergraduate. At the University of Toronto the professor in charge of the physics course told me that he was making a special effort to have

the student realize that an hour of his (the student's) time was a valuable thing. He made it possible for the student to begin his exercises the minute that the hour struck; he had everything done for him in the way of laboratory attendance to expedite his work; he had provided an adding machine to perform computations not possible on the slide-rule, and encouraged every student to use both these mechanisms whenever possible. He looked upon the admirable ventilation of his building as part of a general plan for promoting the efficiency of the student. He told me that if at a lecture the students began to get drowsy, he gave them a little more air than the rules called for and in this way kept them up to their best efficiency. With the idea of making the students' time as profitable as possible, this professor makes a point of the most extensive preparations for lectures. If by more laboratory attendants he can get the apparatus that is used for one experiment more quickly out of the way and another in its place, or if by having four or five people work on the preparation for the lecture he can accomplish a similar result, he considers it money well spent. Considering the great expense to which the universities are put in maintaining especially the undergraduate physics lecture courses, and the large number of students who attend them, it would appear to be good economy to make any outlay for attendance whereby a ten or twenty-five per cent gain can be accomplished in the efficiency with which the lecture hour is used. At some places visited, I am sure that the importance of the fullest preparation for lectures is not appreciated. The tendency, however, is undoubtedly in the right direction. More time is constantly being given to the proper preparation for lectures.

At Columbia University they have adopted the plan of trying to emphasize the importance of dealing with each student individually as to his progress, both mental and moral, rather than of dealing with the students in masses. On two occasions when I was interviewing full professors, students apparently in one of the earlier undergraduate years entered the room. In each case the professor rose from his seat and greeted the student in such a manner as to indicate the heartiest interest in his visit. The effect on the student was marked. I was afterward told that this procedure was a part of a definite policy in this institution, although I did not know this at the time the interviews took place.

At the last college which I visited, almost the opposite of this policy was in operation. Every time the students were mentioned there were evidences that the teachers had in mind the students' scholarly inferiority and waywardness. The difference in these two attitudes was as concrete as anything I encountered.

At Harvard the commons was unofficially reported to me as running at a net loss of $100 a day. And at this rate of loss the service was not considered satisfactory nor was it popular with the students. Steps were being taken to effect an improvement. At Haverford the authorities were purposely spending more for board than they charged and they expected to continue to do so. They felt that the similarity to a well-ordered home which was their endeavor at the commons was one of the most power-

ful influences for good in the college. They had found after trial that the students would not pay a higher rate. Under a higher rate they gradually drifted to private boarding-houses where neither the service, food nor social influences were as good. At one of the large institutions visited they told me that the next money which was received would be spent on building up a college commons where the service and surrounding conditions would be made what a college dining-hall should be without any effort at covering cost in the charges.

These questions of student administration are among the large and practical problems which face college educators. While it is true that the demand for college-bred men is widening,—and at a rate which in the writer's opinion is underestimated by the college world,—it is also true that there is a general feeling among employers that it is wiser to employ a college graduate who has been at work for some one else for some time. It seems to take the average college graduate about two years to adapt himself to business conditions, and most employers seem willing to let some one else pay his wages during this period. Some of the colleges are already trying to surround the student with conditions more like those he will encounter when he starts on his life's work.

No one can be more conscious than the writer of the magnitude of the difficulties and problems confronting the college world, nor more appreciative of the great measure of success with which they have been met. The task of pointing out in detail the many strong points of present conditions would have been far more grateful to one who is entirely in sympathy with the spiritual significance of university life than the study which as an engineer he has been asked to undertake.

Unless my suggestions shall tend to assist those conducting these institutions and their students towards the attainment of their own highest ideals in scholarship, character development and culture, this study will fall short of the purpose for which it was undertaken, for as Dr. Eliot has said:

"Education for efficiency must not be materialistic, prosaic or utilitarian; it must be idealistic, humane and passionate, or it will not win its goal."

PART 2

INTRODUCTION TO TABLES

ALL the important figures used in the following tables have either the printed authority or verbal approval of the respective institutions. In the smaller details, however, I have not hesitated to make approximations and to pro-rate in accordance with what seemed to me to be the facts. Such assumptions at times have been made only after the most painstaking inquiries. In order to reach the result we are seeking it was necessary, however, to make frequently such approximations and pro-ratings. Where, because of the accounting methods used at any one institution, the number of such approximations and pro-ratings seemed to threaten the accuracy of the conclusions, such conclusions were submitted to the institution concerned and approved by them. Throughout Part 2 I have had in mind first of all to suggest a *method* by which the colleges could introduce a cost factor into their system of accounting. Simply to have suggested such a method would not have been sufficient. So I have tried to develop out of the figures gathered a model set of reports which will illustrate completely the application of the method. The whole argument of Part 2 leads up to the dummy reports given on Tables 9 and 10. These tables indicate the general character of the returns which will be obtained should the system here advocated be adopted.

This statement is made to call attention to the difference between the tables here printed and those which ordinarily would be the result of the audit of the books of eight industrial concerns. In many cases the accounting authorities of the universities answered my questions in regard to financial administration with a good deal of reluctance. This latter was not because they objected to giving the information, but because they hesitated to send any information for possible publication which did not come "off the books." In every such case my informant was assured that I intended personally to accept the responsibility for statements made in this report.

The effort has been to make the method of arriving at any given figure as clear as is consistent with the necessary limitations of the report. If all the preliminary figuring had been included in the report itself, or its appendices, it would not only have made it too bulky, but would have required a much longer time for its preparation. The informal data sheets have been retained, and it will be possible at any time to give any one interested further information as to the development of any figure shown in the tables. To get even approximately the broad figures desired, it was necessary to resort to a good many expedients not recognized by accountants. Thus, the class-room records (*i.e.*, the statements as to the quantity of teaching done) are those for the year 1908–09, while the expenses are those for 1907–08, except in the matter of salaries, which are taken for 1908–09.

There is nothing in these tables which indicates the qualitative value of the teaching at the various institutions. The tables are almost entirely quantitative in their significance. On pages 4 and 5 of the introduction a method of gauging quality is suggested.

TABLE 1

This table includes the various valuations upon which plant interest charges are worked out. The difficulties of ascertaining some of these valuations were explained in Part 1; and in some cases the valuations, especially the larger figures, must be considered as the roughest approximations. Here, as elsewhere, the figures may have little value as applied to individual institutions; whereas they may have considerable value for purposes of comparison. Thus, $12,000,000 put down as the whole value of the Harvard plant is only an "intelligent guess." The $6,000,000 assigned to Princeton has probably a larger accounting value. As used here, these figures only indicate that the Princeton plant is worth nearly fifty per cent of the Harvard plant; and this probably is not far from the facts. The same figures on the value of the other plants will give those who have not seen them some sort of an idea of their size. On lines eight and nine are given the valuations of lands and buildings held for joint use, and on lines ten and eleven the value of the building in which physics is chiefly taught and the land on which this building stands. These values are broken up in such a way as to indicate what a large part the land item plays. For instance, the land held for joint use at Haverford is worth four times the value of the buildings, and for the most part is land that is so located as to be quickly marketable. I imagine it is held in large measure for investment purposes. It will be noted that the half million dollar physics building at Princeton stands on land that would be worth about seventy-five hundred dollars if located off the campus, but within a stone-throw of where it is, while the less up-to-date building of the Massachusetts Institute of Technology stands on land assessed at nearly a million dollars.[1]

On lines fourteen, fifteen, sixteen and seventeen, I have given an idea of the way in which Harvard's one hundred thousand dollar physics equipment (apparatus, etc.) is divided up according to its use. These figures were furnished by Professor Trowbridge. The other institutions were unable to give these data without an unwarranted amount of trouble. I have inserted Harvard's figures because they will furnish a general idea on this important point.

While the figures given on line nineteen are all taken from printed reports, they are practically valueless on account of the difference in accounting methods and a difference in interpreting "administration expenses" at the different schools. Thus Harvard's administration expenses appear lower than they really are. Harvard has a crude method of charging off a part of such expenses against the departments. This would be all right of course if it were done in such a way as to make it possible to know what the total administration expenses are. On the other hand Columbia does not appear to charge enough to its departments. This makes its administration expenses

[1] The conditions under which this land is held are quite unusual. An act of the Massachusetts legislature allows the Institute to build on only one-third of this property. Therefore the minimum value of the land chargeable to this building is three times its ground area multiplied by the value per square foot. From figures furnished by the Institute authorities, this becomes 14,040 square feet (area of building) x 3 x $23 (value per square foot listed on city books) = $968,760. In the table following, this is called $900,000.

appear heavier than they really are. The Wisconsin and Massachusetts Institute of Technology attitude seems more nearly right.

The factor given on line twenty-one is the relation between physics-teaching salaries and the total teaching salaries at the institution. This is the figure that I have used in pro-rating overhead expenses in order to arrive at the share which should be assigned to physics. The amount given on line twenty as the total of instructional salaries at Harvard has been questioned, but the figure is one furnished me by the accounting authorities at Harvard. If any change should be made, it would undoubtedly be in the direction of increasing it. This factor in a way illustrates the relative degree of importance assigned to physics at the various institutions; and these figures, with one or two exceptions, reflect the attitude towards physics which I found at the various institutions. Both at Toronto and Princeton, physics was apparently a large factor in the life of the institution. At Haverford I was informed that physics, in common with all sciences, had only recently been encouraged; and at Wisconsin physics was overshadowed by many other branches. I believe this factor, applied to the different departments of instruction, will be very useful in maintaining the relative importance of each such department which the board of trustees desires it to maintain. It should be noted that the "absolute" size of the department of physics at two institutions might be the same, while the size of each as compared with the whole institution could be widely different.

Table 1

VALUATIONS, EXPENDITURES, ETC.

	QUESTION	INSTITUTION							
		Columbia	Harvard	Haverford	Mass. Institute of Technology	Princeton	Toronto	Williams	Wisconsin
1	Founded	1754	1636	1830	1865	1746	1843	1785	1848
2	Number of terms in year	2	2	4	2	2	2	2	2
3	Number of weeks between opening and closing	37	39	38	36	38	36	40	
4	Number of weeks of teaching	30	30	31	30		27	33	33
5	Value of whole plant	11,250,000.00	12,000,000.00	1,500,000.00	3,500,000.00	6,000,000.00	4,500,000.00	2,000,000.00	5,000,000.0
6	Total number students in all departments	3057	3881	160	1462	1314		487	3903
7	Value of those parts of plant held for joint use of all the departments [1]	4,500,000.00	2,500,000.00	750,000.00	300,000.00	1,600,000.00	750,000.00	1,000,000.00	1,500,000.0
8	Value of lands held for joint use	2,000,000.00	1,000,000.00	600,000.00	200,000.00	100,000.00	250,000.00	80,000.00	500,000.0
9	Value of buildings and equipment held for joint use	2,500,000.00	1,500,000.00	150,000.00	100,000.00	1,500,000.00	500,000.00	920,000.00	1,000,000.0
10	Value of building in which physics is chiefly taught	274,113.67	120,000.00	15,000.00	190,000.00	540,000.00	355,000.00	60,000.00	250,000.0
11	Value of land on which physics building stands	170,000.00	75,000.00	3,000.00	900,000.00	7,500.00	53,120.00	1,000.00	115,776.0
12	Value of land and building actually used for physics	355,290.00	195,000.00	9,000.00	571,160.00	511,000.00	408,120.00	57,706.00	146,310.0
13	Value of physics equipment	40,000.00	100,000.00	1,100.00	110,000.00	45,000.00	120,000.00	15,000.00	45,000.00
14	Value of part used for lectures		10,000.00						
15	Value of part used for laboratory		90,000.00						
16	Value of part used in undergraduate laboratories		15,000.00						
17	Value of part used in research		75,000.00						
18	Total annual expenditures in all departments	1,330,156.36	1,880,525.27	106,203.49	517,762.89	588,572.85	613,344.55	213,000.00	1,091,135.3
19	Administrative expenses for institution as a whole	258,456.12	123,154.39	28,252.33	67,936.85	172,008.99	143,294.00	66,151.02	146,516.9
20	Total instructional salaries	541,702.00	577,760.00	45,800.00	313,077.47	339,150.00	262,380.04	96,000.00	554,119.0
21	*Physics instructional salaries* / Total instructional salaries	.065	.053	.044	.066	.072	.072	.036	.037
22									
23									
24									
25									

[1] This does not include dormitories and other productive property.

TABLE 2

THE upper section of this table shows the number of teachers at each of the institutions visited and how they are divided between the different grades.

The lower section gives figures in regard to the much debated question of inbreeding. It affords a splendid illustration of the value of figures as an index to actual conditions. At several places Harvard was held up to me as a "horrible example" of what was generally conceded to be *high-class* inbreeding. The figures show that Harvard stands about midway, and probably occupies the safest position of all in this matter.

The table also shows that of the seventeen physics teachers at the Massachusetts Institute of Technology all are its own graduates. The University of Toronto almost equals this record, with 91 per cent of its teachers alumni of the institution.

It would seem that either an extremely high percentage or an extremely low percentage of teachers drawn from the school at which they teach is bad practice. There was one marked instance (perhaps two) where the department of physics seemed to lack solidarity on account of the large number of teachers drawn from other institutions. There was enthusiasm for physics, but little for the institution or the physics department.

Of course this matter is one very difficult to reduce to figures, but it certainly would seem to be advisable to have some percentage of inbreeding which, other things being equal, would be considered about right. Any additions to a staff which caused the percentage to rise above this danger line would be more apt to be made advisedly.

Table 2

DATA CONCERNING INBREEDING OF TEACHERS OF PHYSICS

	QUESTION	INSTITUTION								
		Columbia	Harvard	Haverford	Mass. Institute Tech.	Princeton	Toronto	Williams	Wisconsin	
26	Total Number of Teachers in Physics Staff *These are divided by grade as follows:*	17	12	1	17	15	11	2	22	97
27	Professors	4	4		2	5	2	1	2	20
28	Associate Professors				2				1	3
29	Assistant Professors		2		2	3			3	10
30	Adjunct Professors	3								3
31	Instructors	3	2	1	5	2		1	5	19
32	Demonstrators						3			3
33	Tutors	1								1
34	Assistants	6	3		6				9	24
35	Assistant Demonstrators						3			3
36	Class Assistants						2			2
37	Fellows		1			4	1		1	7
38	Scholars					1			1	2
39	Inbreeding									
40	Number of Members of Physics Staff without Training elsewhere	1	5		12	2	9		5	
41	Number of Members of Physics Staff without Undergraduate Training elsewhere	4	7	1	17	4	10		5	
42	Number of Members of Physics Staff without Graduate Training elsewhere	6	8		12	9	7		16	
43	Number of Members of Physics Staff with both Graduate and Undergraduate Training elsewhere	7	3			4		2	4	
44										
45	Number of Different Schools represented by Degrees	19	10	1	4	15	4	4	19	
46										
47	Percentage Entirely Home Bred	6	39		70	13	64		23	
48	Without Undergraduate Training elsewhere	23	58		100	27	91		23	
49	Without Graduate Training elsewhere	35	67	100	70	60	33		73	
50	With Graduate and Undergraduate Training elsewhere	41	23			27		100	18	

TABLE 3

The salary question has been so thoroughly covered by the Carnegie Foundation that further figures are really unnecessary. It occurred to me, however, that the synopsis given on this table would be interesting in connection with other parts of the report. Special attention is called to the totals, by institution and by grade, given at the bottom of the right-hand page. In order to reduce the number of grades, I have taken the liberty of combining the adjunct professors found at Columbia with the assistant professors; the demonstrators at Toronto with instructors; and the assistant demonstrators with the assistants. So far as I could discern there were no differences in salary or duties.

Grade	Institution	Name	Salary[1]	Averages		Totals	
				By Schools	*By Grade*	*By Schools*	*By Grade*
PROFESSORS [20]	*Columbia*	No. 1					
		2					
		3					
		4		4,250		17,000	
	Harvard	5					
		6					
		7					
		8		5,250		21,000	
	Massachusetts Institute of Technology	9					
		10		3,500		7,000	
	Toronto	11					
		12		3,150		6,300	
	Wisconsin	13					
		14		2,850		5,700	
	Princeton	15					
		16					
		17					
		18					
		19		3,300		16,500	
	Williams	20		2,500	3,800	2,500	76,000
ASSOCIATE PROFESSORS [3]	*Massachusetts Institute of Technology*	21					
		22		1,900		3,800	
	Wisconsin	23		2,500	2,100	2,500	6,300
ASSISTANT PROFESSORS [13] (*Called Adjunct Professors at Columbia*)	*Harvard*	24					
		25		2,500		5,000	
	Massachusetts Institute of Technology	26					
		27		1,600		3,200	
	Wisconsin	28					
		29					
		30		1,400		4,200	
	Princeton	31					
		32					
		33		2,000		6,000	
	Columbia	34					
		35					
		36		2,333	1,954	7,000	25,400
INSTRUCTORS [22] (*Called Demonstrators at Toronto*)	*Columbia*	37					
		38					
		39		1,833		5,500	
	Harvard	40					
		41		1,400		2,800	
	Haverford	42		1,800		1,800	
	Massachusetts Institute of Technology	43					
		44					
		45					
		46					
		47		920		4,600	
	Wisconsin	48					
		49					
		50					
		51					
		52		960		4,800	
	Williams	53		1,000		1,000	
	Princeton	54					
		55		1,000		2,000	
	Toronto	56					
		57					
		58		1,566	1,236	4,700	27,200

[1] Individual salaries given in the original text of the Report are omitted.

OF TEACHERS OF PHYSICS

Grade	Institution	Name	Salary[1]	Averages		Totals	
				By Schools	*By Grade*	*By Schools*	*By Grade*
Tutor [1]	*Columbia*	No. 59		1,100	1,100	1,100	1,100
Assistants [27] (*Called Assistant Demonstrators at Toronto*)	*Columbia*	60					
		61					
		62					
		63					
		64					
		65		500		3,000	
	Harvard	66					
		67					
		68		475		1,425	
	Massachusetts Institute of Technology	69					
		70					
		71					
		72					
		73					
		74		500		2,750	
	Wisconsin	75					
		76					
		77					
		78					
		79					
		80					
		81					
		82					
		83		411		3,700	
	Toronto	84					
		85					
		86		633	473	1,900	12,775
Class Assistants [2]	*Toronto*	87					
		88		225	225	450	450
Fellows [7]	*Harvard*	89		700		700	
	Princeton	90					
		91					
		92					
		93		600		2,400	
	Toronto	94		500		500	
	Wisconsin	95		400	571	400	4,000
Scholars [2]	*Wisconsin*	96		225		225	
	Princeton	97		300	262	300	525

TOTALS				
By Institution			*By Grade*	
Columbia	33,600.00		Professors	76,000.00
Harvard	30,925.00		Associate Professors	6,300.00
Haverford	1,800.00		Assistant Professors	25,400.00
Massachusetts Technology	21,350.00		Instructors	27,200.00
Princeton	27,200.00		Assistants	12,775.00
Toronto	13,850.00		Fellows	4,000.00
Williams	3,500.00		Scholars	525.00
Wisconsin	21,525.00		Tutors, Lecturers and Class Assistants	1,500.00
Total	153,750.00		*Total*	153,750.00

[1] Individual salaries given in the original text of the Report are omitted.

TABLE 3A

THIS is a table of percentages, showing the relative amounts of money which are paid to the different teaching grades. Elsewhere in the report I have shown that in these eight departments of physics forty-five per cent of the whole expense connected with teaching physics goes into instructional salaries, hence it is an item which should receive considerable attention. This table shows that there is the greatest variety of practice in the matter of the relative amounts of money which go to different grades. For instance, at Harvard, eighty-four per cent of all instructional salaries in physics goes to teachers above the instructor's grade; whereas at Toronto, less than thirty-eight per cent only is paid to those above the instructor's grade. I cannot help but feel that this low figure at Toronto is in large measure made possible by the beginnings which have been made in a functional system of management. The Harvard figure certainly bears out the oft-repeated statement that at this institution the lion's share of the salaries goes to those who have been a long time in the service of the institution.

Table 3a

PERCENTAGE OF SALARY PAID TO EACH GRADE OF TEACHER

	The Figures given are Percentages								
		Institutions							
	Averages	*Columbia*	*Harvard*	*Haverford*	*Massachusetts Institute of Technology*	*Princeton*	*Toronto*	*Williams*	*Wisconsin*
Proportion of Salary paid Physics Teachers above the Instructor's Grade	69	71	84		66	83	38	72	58
Proportion of Salary paid Physics Teachers of Instructor's Grade and Below	31	29	16	100	34	17	62	28	42
The Proportion of Salary paid each grade is as follows: Professors	49	51	68		33	61	38	72	26
Associate Professors	4				18	22			12
Assistant Professors	16	20	16		15				20
Instructors	17	16	9	100	21	7	28	28	22
Assistants	8	9	5		13		12		18
Fellows	3		2			9	9		1
Scattering	3	4				1	13		1

TABLE 4

THESE figures are summaries of the individual reports made by the teachers falling in the four principal grades of professor, assistant professor, instructor, and assistant. In the Appendix, Exhibit C, is given a sample of the report form and the instructions under which it was filled out by these teachers. The reports themselves, as filled out by the various teachers, have been filed with the Carnegie Foundation. In many instances, these summaries are the joint product of the report as made out by the teacher and information secured by the writer from other sources. It was absolutely necessary to edit these reports on account of the different interpretation put on the instructions by different men and the varying degree of care with which the reports were made out. For the most part they have been checked up with the schedule of exercises furnished by each department, and in this way many obvious errors corrected. In the same way, many minor entries which do not materially affect the problem have been omitted, in order to simplify it.

Relatively little importance should be attached to the total number of hours per week reported, because in some instances the reports were apparently made out on the theory that the teacher was continuously engaged between certain hours and that, therefore, some data must necessarily be put down. The total number of hours reported does mean something, especially where the figures for such a large number of teachers can be averaged; but the total number of hours reported has not, in my opinion, nearly as much significance as have the figures which show how this time so reported is divided up. It should be noted that the time reported refers only to the time between eight a. m and six p. m. Many of the professors desired to make a report on what they did with their time after six p. m., and others desired an opportunity to show what they did with their time in the summer months—on research and in preparation for the next school year. I did not feel that it would be profitable to conduct such an investigation. It did not seem to me to be desirable to go outside of the hours between eight and six, which for the business and professional man is considered a "working day." For if we could not make such an investigation apply to everybody, to have data of this kind about a few would not have added materially to our information. It must be remembered, of course, that at most institutions the teachers put in more or less time outside of the thirty teaching weeks; but if instruction is the main object of these institutions, the study of conditions during the teaching weeks will always be of paramount importance.

The number in the brackets following the grade is the number of individuals of that grade included in the returns. In interpreting these individual reports every effort was made to "favor" the record. This was only fair in view of the conscientious manner in which the reports had been filled in.

A SUMMARY OF THE INDIVIDUAL REPORTS OF THE TEACHERS OF PHYSICS

A SUMMARY OF THE INDIVIDUAL REPORTS MADE BY THE TEACHERS
8 A.M. AND 6 P.M., FROM MONDAY

	Grade																
	Professors [20]																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Total Hours per Week reported	29	34	35	36	42	35	48	36	30	33	30	38	33	48	26	32	29
This Time is divided in three parts as follows:																	
Time spent with Students	11	11	17	9	11	6	15	11	10	23	12	16	12	14	10	16	20
Time spent on Research		15	5	15	18	10	10	10			4	4	13		2	10	
Miscellaneous	18	8	13	12	13	19	21	15	20	10	14	18	8	34	14	6	9
The Time spent with Students is divided in four parts as follows:																	
Laboratory Exercises					6	2	9			9		8	5		4	8	4
Lectures	8	7	4	8		4	6	4	6	4	10	8	6	5	2	4	4
Recitations			1		5					1			1	6	4	4	9
Consultations	3	4	12	1				7	4	9	2			3			3
The Miscellaneous Time is divided as follows:																	
Preparation	4	7	5	9		17	20	1	9	1	14	9	6	30	4	5	2
Meetings	6	1	3		1	1	1	2	2	2		1	1		1	1	4
Colloquium			1			1						2	1				
Administrative	8		4	3	12			12	6	5		6		4	4		3
Correcting Papers, etc.																	
Attending Lectures as Student																	
Study									3	2							
Tutoring																	
Bookwriting															5		
Assisting at Lectures																	
The Preparation Time is divided as follows:																	
For Lectures	4	7	5	9		17	20	1	9	1	14	9	6	30	4	5	2
For Recitations																	
For Laboratory																	

OF PHYSICS AS TO THE DISPOSITION OF THEIR TIME BETWEEN
TO SATURDAY INCLUSIVE

Table 4
(*continued on pages 88 and 89*)

Grade																															
Professors (continued)					Assistant Professors [13]															Instructors [22]									
18	19	20	Totals	Average time per week in hours	1	2	3	4	5	6	7	8	9	10	11	12	13	Totals	Average time per week in hours	1	2	3	4	5	6	7	8				
36	29	33	692	34.60	46	44	28	38	39	27	39	33	29	33	35	37	35	463	35.61	37	30	33	45	48	35	30	32				
12	7	19	262	13.10	17	19	20	14	13	10	17	8	11	21	11	21	8	190	14.61	27	11	13	18	11	20	17	29				
21	14		151	7.55	26	19		20		12	16	25		12	14		7	151	11.61	5	15	12	25	20	5							
3	8	14	277	13.85	3	6	8	4	26	5	6		18		10	16	20	122	9.38	5	4	8	2	17	10	13	3				
		6	61	3.05	8	16	16	13	11		10		7	12	9	12		114	8.77	27			10	4	8	5	20				
6	5	10	111	5.55	6	3	½	½		6	3	5	2	3	2	4	5	40	3.08		2	6	8	3	6						
	1	2	34	1.70	3		½	½		4		3	2	4			1	18	1.38		9	4		4	2	8	6				
6	1	1	56	2.80			3		2		4			2		5	2	18	1.38			3			4	4	3				
3	7	10	163	8.15	1		3	3	22	5	1		16		6		5	62	4.77	4	3	4	2	7	5						
	1	1	29	1.45	1	2	2	1	4		2		2		1			15	1.15					2	2						
			5	.25	1	1					1					1		4	.30	1	1	1		1							
			67	3.35		3	3									15		21	1.60			2			3						
		3	3	.15											3			3				1					3				
											2							2						1		6					
			5	.25																			6		7					
			5	.25													15	15	1.15											
3	7	10	163	8.15	1		3	3	22	5	1		3		6		5	49	3.77	4	1	3	2	3	5						
			.										13					13	1.00		2	1		4					

A SUMMARY OF THE INDIVIDUAL REPORTS MADE BY THE TEACHERS
8 A.M. AND 6 P.M., FROM MONDAY

GRADE

	INSTRUCTORS (continued)															
	9	10	11	12	13	14	15	16	17	18	19	20	21	22	TOTALS	Average time per week in hours
TOTAL HOURS PER WEEK REPORTED	35	24	32	41	36	23	47	23	36	28	39	33	32	35	754	34.27
This Time is divided in three parts as follows:																
Time spent with Students	16	11	18	20	13	17	8	15	21	17	21	21	22	23	389	17.68
Time spent on Research	7	12	14	21	20		17		3	8	12		4		200	9.09
Miscellaneous	12	1			3	6	22	8	12	3	6	12	6	12	165	7.50
The Time spent with Students is divided in four parts as follows:																
Laboratory Exercises	13		6	6				14	20	16	17	16	13	19	214	9.73
Lectures		2					5	1				5	7	4	49	2.22
Recitations	3	6	8	14	13	13				1	4		2		97	4.41
Consultations		3	4			4	3		1						29	1.32
The Miscellaneous Time is divided as follows:																
Preparation	12	1					10		5		2	8	4	6	73	3.32
Meetings							2		1						7	.32
Colloquium					1							2	2	1	10	.45
Administrative					2										7	.32
Correcting Papers, etc.									6					3	13	.59
Attending Lectures as Student								8		3	4	2		2	26	1.18
Study						6	10								29	1.32
Tutoring																
Bookwriting																
Assisting at Lectures																
The Preparation Time is divided as follows:																
For Lectures	6	1					10						4	4	43	1.95
For Recitations											1				1	.05
For Laboratory	6								5		1	8		2	29	1.32

Table 4
(concluded)

OF PHYSICS AS TO THE DISPOSITION OF THEIR TIME BETWEEN
TO SATURDAY INCLUSIVE

Grade																												
Assistants [27]																											Totals	Average time per week in hours
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27		
32	41	35	31	29	36	45	42	50	38	17	30	39	29	37	37	32	22	28	31	33	35	32	23	34	40	34	912	33.77
6	8		13	11		13	13	12	20	17	18	3	7	26	15	15	16	12	15	14	14	15	16		10	14	323	11.96
14	23	10	18	10	35	23	21	31	10			26		9	11	5		14	5	5	9	9		5	5	4	302	11.19
12	10	25		8	1	9	8	7	8		12	10	22	2	11	12	6	2	11	14	12	8	7	29	25	16	287	10.62
			12	9		13	12	12	20	17	18	3	7	18	15	15	16	12	15	14	14	15	16		10	14	297	11.00
5	4		1	2			1							8													21	.77
1	4																										5	.19
8	6			4			2	2	5		6		18	2	5	5	2	2	4	6	6	3	3	20	19	7	135	5.00
															2	2			2	2	2	2	2				14	.52
2				1																					1	1	5	.19
																								5			5	.19
2		15		3							6					5	4		5	6	4	3	2			4	59	2.19
					1	9	6	2					4											4	3	3	32	1.19
												4			4												8	.29
								3																			3	.11
									2																		2	.07
	4	10							1			6													2	1	24	.89
	6			4			2	2	3		6		9	2	5									20	13	6	78	2.88
2																											2	.07
6									2				9			5	2	2	4	6	6	3	3		6	1	55	2.05

TABLE 5

Especial attention should be called to the time devoted to regular exercises. This shows that the average professor of physics at the institutions visited spends less than two hours a day on regular class-room, laboratory and lecture-hall exercises. The same figure for the assistant professor is 2.40; instructor, 2.97; assistant, 2.14. If the theory is correct that these institutions are operated for the purpose of teaching, then an increase of an hour's work a day in the professorial grade would represent a great increase in efficiency. An analysis of the way in which the average professor spends his time, as shown on this table and the preceding one, would seem to indicate that such an increase is not only possible, but highly desirable.

It seems to me that a fifty per cent increase in the teaching time in the higher grades can be brought about and still leave the teacher more time than he has now for preparation. One of the things from which the teaching profession suffers most is the small amount of time available for what is vital in preparation, *i.e.*, for close study and reflection. Hour after hour is wasted on interruptions necessitated by lack of functional management and to the carrying on of a great load of detail work of which the teacher should be relieved. A teacher will continue to hold the attention of students only as he is given time to grow himself in the knowledge of his subject and of its application to life.

ANALYSIS OF THE DISPOSITION OF THE TIME OF THE TEACHERS OF PHYSICS

	Grades[1]							
	Professors [20][2]							
	Columbia [4]	*Harvard* [4]	*Mass. Tech.* [2]	*Princeton* [5]	*Toronto* [2]	*Williams* [1]	*Wisconsin* [2]	General Average for Grade
Total Time per Day reported[3] in Hours and Decimals of Hours averaged by Institution and by Grade. Thus 6.09 is the average number of hours per day reported by four full professors at Columbia. The general average 6.29 at end of line is for 20 full professors distributed among seven institutions	6.09	7.32	5.73	5.50	6.18	6.00	7.36	6.29
This total time is divided in four parts as follows:								
Time spent with Students	2.18	2.04	3.00	2.33	2.55	3.46	2.33	2.40
Time spent on Research	1.59	2.18		1.71	.73		1.18	1.37
Time preparing for Lectures, Laboratory and Recitations	1.14	1.73	.91	.76	2.09	1.82	3.27	1.48
Miscellaneous	1.18	1.37	1.82	.70	.81	.72	.58	1.04
The Time spent with Students is divided in two parts as follows;								
Time devoted to Regular Exercises Class Room, Laboratory and Lecture Hall coming at Stated Times[4]	1.28	1.63	1.82	1.99	2.37	3.27	2.09	1.87
Time devoted to Consultations with Students	.90	.41	1.18	.34	.18	.19	.24	.52
The Time devoted to Regular Exercises is divided in three parts as follows:								
Laboratory Exercises[4]		.77	.82	.58	.73	1.09	.45	.55
Lectures	1.23	.64	.91	.76	1.64	1.82	1.00	1.01
Recitations[4]	.05	.22	.09	.65		.36	.64	.31

[1] The grades of Associate Professor [3], Tutor [1], Class Assistants [2], Fellows [7], and Scholar [2] are omitted because of the small numbers, all these grades together making about 14 per cent only of the teachers included in this study. In point salary these grades represent about 8 per cent.

[2] The numbers in brackets indicate the number of individuals included in the averages given.

Table 5

OF THE TEACHERS OF PHYSICS, 8 A.M. TO 6 P.M.

GRADES[1]																					
ASSISTANT PROFESSORS [13]							INSTRUCTORS [22]								ASSISTANTS [27]						
Columbia [3]	*Harvard* [2]	*Mass. Tech.* [2]	*Princeton* [3]	*Wisconsin* [3]	General Average for Grade	*Columbia* [3]	*Harvard* [2]	*Haverford* [1]	*Mass. Tech.* [5]	*Princeton* [2]	*Toronto* [3]	*Williams* [1]	*Wisconsin* [5]	General Average for Grade	*Columbia* [6]	*Harvard* [3]	*Mass. Tech.* [6]	*Toronto* [3]	*Wisconsin* [9]	General Average for Grade	
.49	8.18	6.00	5.76	6.36	6.47	6.06	8.45	6.36	5.56	6.09	6.06	6.55	6.18	6.23	6.18	8.30	7.68	6.54	5.52	6.56	
.42	3.27	3.09	2.42	2.42	2.66	3.09	2.64	3.62	3.31	3.45	4.00	3.82	2.65	3.21	1.15	2.30	3.68	1.45	2.67	2.38	
.27	4.09	1.82	2.24	1.70	2.11	1.94	4.09	.90	1.20	1.82	.24	.55	2.11	1.65	3.33	4.54	1.82	.85	1.17	2.13	
.66	.10	.54	.97	1.70	.87	.66	.82	.91	.48	.18	.97	.91	.36	.59	.55	.24	1.25	2.79	.73	.98	
.14	.72	.55	.13	.54	.84	.37	.90	.93	.57	.64	.85	1.27	1.06	.77	1.15	1.22	.93	1.45	.95	1.07	
.99	3.27	2.82	2.30	2.05	2.40	2.90	2.64	2.91	2.84	3.45	4.00	3.64	2.40	2.97	1.00	2.30	3.68	1.45	2.67	2.34	
.43		.27	.12	.37	.26	.19		.71	.47			.18	.25	.23	.15					.03	
.27	2.18	2.64	1.15	1.27	1.59	1.63	1.27	1.45	1.64	3.00	2.91	3.64	.73	1.77	.64	2.24	3.35	1.45	2.67	2.18	
.66	.82	.09	.61	.54	.56	.48	1.00	1.09	.07		.97		.22	.40							
.06	.27	.09	.54	.24	.25	.79	.37	.37	1.13	.45	.12		1.45	.80	.36	.06	.33			.16	

sample report form and instructions, see Appendix, Exhibit C.

se figures cannot vary much from week to week. For the most part they have been checked with the schedule of exer-. They are subject to proof. They are practically independent of the personal equation.

TABLE 5A

To get the figures in the first table, I have taken the average salary for a year for each grade and divided by thirty teaching weeks. This gives the average salary per teaching week for each grade. I have then divided up this weekly compensation in proportion to the time spent on (1) teaching proper, (2) research, and (3) miscellaneous, in accordance with the summary of the individual reports of the teachers. This shows that, on the average, fifty dollars a week is paid to every professor for doing miscellaneous things. A large part of this, but not half of it, goes into preparation for lectures. It would certainly seem that large improvement can be brought about here through employing more assistants, who will relieve the higher grades of much of the detail work which now consumes so large a part of their time. It is absolutely necessary for those planning the work of a department to know exactly what an hour of each worker's time is worth. There is no other way of utilizing all the labor—high and low—to the best advantage.

It has been suggested that since, in many cases, these assistants are secured at low salaries because of the opportunity to do research work, their salaries should be considered as being paid exclusively for teaching and therefore charged to the teaching account. This contention does not seem sound from an accounting standpoint. These men receive no regular compensation from any other source for the time they spend on research. They occupy quarters and use supplies owned by the university, and in case apparatus is damaged the university makes good the loss.

In the second table, I have tried to give an idea of the value of a "productive" hour for each grade. If a professor, engaged at an average salary of $3800 a year, teaches thirty weeks in the year, and for every hour spent with students spends over one and one-half hours on research and miscellaneous duties, it makes the cost of an hour actually spent in the lecture room over ten dollars.

Table 5a

MONEY VALUE OF THE TIME OF TEACHERS OF PHYSICS

On the basis of the physics departments visited, teaching salaries represent 45 per cent of all expenses. An understanding of the relations between salaries paid different grades becomes imperative in any study of efficiency	Grade			
	Professor	Assistant Professor	Instructor	Assistant
Money Value Weeks Time [Salary] averaged for Grade	126.66	65.13	41.20	15.77
This is divided in three parts as follows: [1]				
Money Value Time spent with Students	48.31	26.75	21.22	5.65
Money Value Time spent on Research	27.63	21.24	10.91	5.29
Money Value Time spent other than on Teaching or Research	50.72	17.14	9.00	4.83

[1] The weekly compensation is divided up in accordance with the reports made by individual teachers. The large amount of miscellaneous time in the professorial grade is especially noticeable.

Some such table as this would be useful in estimating the probable cost of a proposed course in the matter of teaching salaries	Grade			
	Professor	Assistant Professor	Instructor	Assistant
Average Salary per Annum	3800	1954	1236	473
Average Salary per Teaching Week	126.66	65.13	41.20	15.77
Average Salary per Hour as reported engaged	3.66	1.83	1.20	.47
Average Salary per Hour spent with Students	9.59	4.46	2.33	1.32

TABLE 6

Floor plans were made of the various rooms in which physics is taught at each of the eight institutions visited. The floor space devoted to different kinds of departmental work was then added together and the totals given in this table secured. In the matter of rooms that were used by the physics department in common with other departments, I assigned to physics that part of the floor space which was represented by its use. It was not always possible to find out how many hours a week a given room was used, but if physics used it ten hours I charged physics with half the expense of the room, if I found the physics department used rooms which it controlled exclusively, of the same character, on an average of twenty hours a week.

Just as I have assumed that the colleges were operated for their teaching departments, I have assumed that a physical laboratory is operated for those parts where teaching is actually done; that is, in the undergraduate and research laboratories, recitation rooms and lecture halls. I have considered the expense of operating storerooms, studies, apparatus rooms, etc., as an overhead charge to be pro-rated over the net floor space available for teaching purposes. A study of this table will show the greatest difference in the amount of the net floor space available for teaching purposes as compared with the total floor space. Thus, at Princeton, the total floor space is 48,000 square feet, of which 28,000 are available for teaching purposes; while at Harvard the total floor space is 29,000 square feet, of which 26,000 are available for teaching purposes. Considering its cost this building at Harvard seems wonderfully efficient.

It is interesting to compare the relative standing of the several institutions in the matter of the expense of operating and maintaining their buildings. Judged both by the expense per student-hour and expense per square foot available for teaching purposes, Princeton's building is the most expensively operated and Harvard's is the most economically. There seems to be a general relation all the way through between the results obtained by using these two methods; but it is difficult to say which is going to be ultimately the best gauge of efficiency.

It seems only fair to say that the accounting methods at Harvard are such that the figures which I have gathered in regard to the expense of any one part of their work do not appear to be as trustworthy as are those gathered from the other institutions. The totals are, without much doubt, correct; but there has been at times a deal of uncertainty as to the proper disbursement for certain detail charges of which the totals are made up. I was not in every case able to get satisfactory answers without putting the accounting authorities to more trouble than was warranted. The books are not designed to answer these questions. So long as the central accounting authorities at Harvard know as little as they do about the details of the financial operations of the individual departments, it will be well-nigh impossible to get costs which are fully comparable with those secured at other institutions. These same general conditions are present in greater or less degree at all colleges.

DATA CONCERNING BUILDINGS, COST OF MAINTENANCE, ETC.

		INSTITUTION							
		Columbia	Harvard	Haverford	Mass. Institute Tech.	Princeton	Toronto	Williams	Wiscon
51	Total Floor Space used for Physics[1] *This space is divided as follows:*	24,424	29,293	2,310	23,742	48,391	48,138	9,883	20,54
52	Part used for Undergraduate Laboratories	6,908	12,093	1,284	13,312	12,793	24,807	6,207	8,79
53	Part used for Recitation Rooms	4,189	2,136	*Lecture room used for recitations*	1,692	2,464	2,552	200	1,30
54	Part used for Lecture Rooms	1,782	3,502	576	3,198	6,920	5,616	1,320	2,00
55	Part used for Research Laboratories	6,396	8,636	225	1,056	6,214	6,175	270	4,34
56	Part used for Studies	1,292	667		1,458	2,082	3,042	345	842
57	Part used for Reading Rooms, Libraries, etc.	368	340		1,521	1,056	1,542	299	665
58	Part used for Shop	1,122	1,409	225	725	3,856	1,512	570	1,00
59	Part used for Apparatus Rooms	2,367	510		780	2,512	2,992	462	1,60
60	Part used for Bed Room							210	
61	Part Vacant					10,494			
62	Net Floor Space Available for Teaching Purposes[2]	19,275	26,367	2,085	19,258	28,391	39,050	7,997	16,4
63	Total Cost Maintaining and Operating Building *This cost is divided in two parts:*	20,415.29	11,135.58	711.85	28,641.58	30,140.00	23,135.70	3,301.74	10,437
64	Interest [estimate] on Investment	14,211.60	7,800.00	360.00	22,846.40	20,440.00	16,324.60	2,308.24	5,800
65	Expense Maintaining and Operating Building	6,203.69	3,335.58	405.85	5,795.18	9,700.00	6,811.10	993.50	4,637
66	Average Cost per square foot of Floor Space per year *This cost is divided in three parts:*	1.05	.42	.37	1.49	1.06	.59	.41	.63
67	Average Cost per square foot Interest on Land	.28	.11	.03	.94	.01	.05	.01	.11
68	Average Cost per square foot Interest on Building	.45	.18	.14	.25	.71	.36	.28	.24
69	Average Cost per square foot Operating Expenses	.32	.13	.20	.30	.34	.18	.12	.28
70	Maintenance and Operation of Building Expense per Student-Hour	.07	.05	.08	.07	.12	.08	.08	.06
71									
72									
73									
74									
75									

[1] ased on exclusive use. [2] Net floor space = sum of floor space shown opposite 52-53-54-55 above. This is floor space used in computing exp

TABLE 7

In examining this table the main point to be considered is to bear in mind the difference between *cost* and *expense* as defined on the table itself. As it never had been done, it occurred to me that it would be interesting to estimate the whole cost of teaching physics. By "whole cost," I mean what would be considered cost in a manufacturing establishment, where dividends must be paid on the invested capital as well as interest on borrowed money. The cost, therefore, as here used includes a nominal interest at four per cent, not only on the buildings and equipment used for physics, but on those buildings and that equipment which are used by physics students in common with the students of the other departments.

Expense, as here used, includes the overhead charge for administration of the institution as a whole, as well as the various direct expenses which are connected with the physics department. As a matter of fact, it is hardly possible that, for some time at least, cost as here used will form a part of the accounting system of American schools and colleges, but it is just as well to have cost in mind in any accounting system that is devised. Efficient management is out of the question unless the administrator has just as much respect for cost items as for expense items as here defined. In the long run both must be met.

It will be interesting to have in mind the methods by which the various items were apportioned as between research and teaching. The "Maintenance and Operation of Building Expense"was pro-rated in the proportion of the amount of floor space available to that used for research. The "Equipment and Supplies Expense" was apportioned largely as the result of discussions with the heads of the various departments, *i.e.*, by finding out what part of the appropriation was used for research. The "Other Salaries Expense" (paid to mechanicians and laboratory attendants) is pro-rated according to the duties of those to whom the salaries are paid. The "Teaching Salary Expense" is pro-rated by individual salaries and in accordance with the reports made by the teachers, personally, as to the percentage of time devoted to research. The interest on physical equipment is divided in proportion to the amount of equipment used for research and that used for teaching purposes. This was also obtained through personal interviews. The interest on land, building and fixtures is divided between research and teaching in the proportion of the amount of physics-teaching salaries assigned to research and that assigned to teaching proper. Administration expense and the interest on the buildings and equipment used by the students of the physics department in common with those of other departments are both pro-rated in accordance with the relation which the physics-teaching salaries bear to the total instructional salaries.

The totals on the extreme right of Table 7 show that approximately thirty per cent of the cost of operating a physics department goes into research.

In figuring out the Toronto costs, no charge was made for the use of the rooms

occupied by Professor Loudon and his assistant in University Hall. This would be small at best; it would have been difficult to obtain, and the main physics building is sufficiently large to house these sections if it were called on to do so. The costs as figured out for Toronto are too low by just this amount. All the other expenses connected with Professor Loudon's department of physical mathematics are, of course, included.

The physics at the University of Toronto presented in this report is that given by the faculty of arts. A small amount of physics teaching is given by the faculty of applied science and engineering. Neither this teaching nor its expense is included as a part of this report. This implies that the total number of student-hours in physics as given for the University of Toronto is too low by just the amount given in the engineering building. The cost per student-hour, however, is right, because while the physics teaching in the engineering building has not been added, neither has its cost.

It was not possible in every case to make the bounds of what we considered the physics department the same at each of the institutions. This will not affect the general validity of the results, however, because where we excluded any branch we excluded the costs which accompanied it, and when we added a branch we added the costs. In general the departments cover approximately the same field.

In preparing this statement of costs, I had some difficulty in deciding what to do with the annual expenditures for equipment. Usually the appropriation is for "Equipment and Supplies," and no difference is made as between purchases of supplies proper and those things which add to the permanent value of the plant. At some institutions the purchase of even expensive items of apparatus is handled as an expense. As it was impossible for the institutions to give me even an approximate idea as to how this "Equipment and Supplies" item was divided, I have considered this year's purchases of equipment as supplies, and therefore as an expense, and figured interest on the present value of apparatus purchased prior to this year and on hand. There is of course no precedent for handling equipment purchases in this way, but it seemed as good a compromise as could be arrived at. It will have a tendency to make expenses a little higher than they really are. But as this whole equipment item is one that is very small, it makes no material difference in the general result.

	INSTITUTION								
	COLUMBIA			HARVARD			HAVERFORD		
	Total	Research	Teaching	Total	Research	Teaching	Total	Research	Teac ing
IE TOTAL COST OF PHYSICS. This cost includes not only all items of current expense, but also nominal interest on the plant and equipment used. It s "cost" in the manufacturing sense	90,438.11	27,520.88	62,917.23	70,883.84	36,925.49	33,958.35	5,422.95	840.79	4,582
e Total Cost is divided in two parts as follows:									
NDIRECT COST. This indirect cost is the physics department's share of those overhead cost items which, being incurred by the institution as a whole, must be apportioned to the teaching departments in proportion to the amount of their teaching salaries	28,499.64	7,979.90	20,519.74	11,827.18	5,913.59	5,913.59	2,563.10	367.58	2,195
IRECT COST. This direct cost includes all those items of cost which can be directly charged to the physics department without any apportioning	61,938.47	19,540.98	42,397.49	59,056.66	31,011.90	28,044.76	2,859.85	473.21	2,386
e Indirect Cost is divided in two parts as follows:									
INTEREST. This is a nominal interest at 4 per cent estimated on the value of the "unproductive" parts of the whole institution used by physics students in common with those of other departments	11,700.00	3,276.00	8,424.00	5,300.00	2,650.00	2,650.00	1,320.00	188.57	1,131
ADMINISTRATION EXPENSE. Physics share overhead expenses of the whole institution apportioned in proportion to the physics teaching salaries	16,799.64	4,703.90	12,095.74	6,527.18	3,263.59	3,263.59	1,243.10	179.01	1,064
e Direct Cost is divided in two parts as follows:									
INTEREST. This is a nominal interest at 4 per cent on the estimated value of the land, building and equipment used by physics exclusively	15,811.60	5,337.20	10,474.40	11,800.00	5,262.00	6,538.00	404.00	71.42	332
DIRECT EXPENSE. Being all expense items directly chargeable to the physics department	46,126.87	14,203.78	31,923.09	47,256.66	25,749.90	21,506.76	2,455.85	401.79	2,054
e Direct Interest is divided in two parts as follows:									
ON LAND, BUILDING AND FIXTURES	14,211.60	4,737.20	9,474.40	7,800.00	2,262.00	5,538.00	360.00	51.42	308
ON PHYSICAL EQUIPMENT	1,600.00	600.00	1,000.00	4,000.00	3,000.00	1,000.00	44.00	20.00	24
e Direct Expense is divided in four parts as follows:									
PHYSICS TEACHING SALARY EXPENSE	33,600.00	9,290.00	24,310.00	30,925.00	15,535.00	15,390.00	1,800.00	257.14	1,542
OTHER SALARIES EXPENSE such as mechanicians, laboratory attendants, etc., but not including janitors and power plant employed	2,100.00	1,100.00	1,000.00	5,789.50	4,449.50	1,340.00	50.00		50.
EQUIPMENT AND SUPPLIES EXPENSE	4,223.18	1,723.18	2,500.00	7,206.58	4,706.58	2,500.00	200.00	100.00	100.
MAINTENANCE AND OPERATION OF BUILDING EXPENSE	6,203.69	2,090.60	4,113.09	3,335.58	1,058.82	2,276.76	405.85	44.65	361.
ERCENTAGES OF WHOLE COST chargeable to research and to teaching proper		.304	.696		.521	.479		.155	.845
ERCENTAGES OF DIRECT EXPENSE chargeable to research and to teaching proper		.301	.699		.545	.455		.163	.837

PORTIONS CHARGEABLE RESPECTIVELY TO RESEARCH AND TO TEACHING PROPER

INSTITUTION

Massachusetts Institute of Technology			Princeton			Toronto			Williams			Wisconsin			Totals		
Total	Re-search	Teach-ing	Total	Re-search	Teach-ing	Total	Re-search	Teach-ing	Total	Re-search	Teach-ing	Total	Re-search	Teach-ing	Grand Total	Re-search Total	Te i To
7,053.23	8,930.50	58,122.73	84,542.58	27,229.65	57,312.93	62,525.90	12,399.18	50,126.72	12,473.18	465.83	12,007.35	48,876.84	15,578.85	33,297.99	442,216.63	129,891.17	312,
5,275.83	738.61	4,537.22	16,992.58	6,287.25	10,705.33	12,477.17	1,372.49	11,104.68	3,821.44	76.43	3,745.01	7,820.00	2,111.40	5,708.60	89,276.94	24,847.25	64,
1,777.40	8,191.89	53,585.51	67,550.00	20,942.40	46,607.60	50,048.73	11,026.69	39,022.04	8,651.74	389.40	8,262.34	41,056.84	13,467.45	27,589.39	352,939.69	105,043.92	247,
792.00	110.88	681.12	4,608.00	1,704.96	2,903.04	2,160.00	237.60	1,922.40	1,440.00	28.80	1,411.20	2,220.00	599.40	1,620.60	29,540.00	8,796.21	20,
1,483.83	627.73	3,856.10	12,384.58	4,582.29	7,802.29	10,317.17	1,134.89	9,182.28	2,381.44	47.63	2,333.81	5,600.00	1,512.00	4,088.00	59,736.94	16,051.04	43,
,246.40	2,142.32	25,104.08	22,240.00	4,270.40	17,969.60	21,124.60	4,411.93	16,712.67	2,908.24	116.33	2,791.91	7,600.00	2,408.00	5,192.00	109,134.24	24,019.60	85,
,531.00	6,049.57	28,481.43	45,310.00	16,672.00	28,638.00	28,924.13	6,614.76	22,309.37	5,743.50	273.07	5,470.43	33,456.84	11,059.45	22,397.39	243,804.85	81,024.32	162,
,846.40	1,142.32	21,704.08	20,440.00	3,270.40	17,169.60	16,324.60	2,611.93	13,712.67	2,308.24	92.33	2,215.91	5,800.00	1,508.00	4,292.00	90,090.84	15,675.60	74,
,400.00	1,000.00	3,400.00	1,800.00	1,000.00	800.00	4,800.00	1,800.00	3,000.00	600.00	24.00	576.00	1,800.00	900.00	900.00	19,044.00	8,344.00	10,
,350.00	2,690.00	18,660.00	27,200.00	10,110.00	17,090.00	13,850.00	1,525.00	12,325.00	3,500.00	83.33	3,416.67	21,525.00	5,821.00	15,704.00	153,760.00	45,311.47	108,
,066.00	750.00	1,316.00	3,860.00	2,960.00	900.00	2,380.00	1,500.00	880.00	250.00	50.00	200.00	2,294.82	1,428.44	866.38	18,790.32	12,237.94	6,5
,319.82	2,319.82	3,000.00	4,550.00	2,050.00	2,500.00	5,883.03	2,500.00	3,383.03	1,000.00	100.00	900.00	5,000.00	2,500.00	2,500.00	33,382.61	15,999.58	17,3
,795.18	289.75	5,505.43	9,700.00	1,552.00	8,148.00	6,811.10	1,089.76	5,721.34	993.50	39.74	953.76	4,637.02	1,310.01	3,327.01	37,881.92	7,475.33	30,40
	.133	.867		.367	.633		.198	.802		.036	.964		.318	.682		.293	.707
	.175	.825		.322	.678		.229	.771		.048	.952		.330	.670		.332	.668

TABLE 8

These costs per student-hour at the different institutions are obtained by dividing the total number of student-hours into the total cost of operating the department. This total cost per student-hour is in turn divided into three parts, two of which are further subdivided. Administration expense and direct expense taken together constitute the total expense of teaching physics. After this matter of costs has been studied for some time and the causes for the obvious discrepancies removed, it will pay to add another decimal place. It seemed to me that to have done this at the present time would have indicated a degree of precision in these results which is not claimed for them. The two decimal places, however, present very distinctly many apparently unwarranted differences in the conditions at the several institutions.

Table 8

COST OF TEACHING PHYSICS PER STUDENT–HOUR

	INSTITUTION								AVERAGES
	COLUMBIA	HARVARD	HAVERFORD	MASS. INSTITUTE TECH.	PRINCETON	TORONTO	WILLIAMS	WISCONSIN	
TOTAL COST OF PHYSICS PER STUDENT-HOUR	1.08	1.08	1.08	.81	.99	.69	.95	.60	.87
The total cost is divided in three parts as follows: Interest on Plant and Equipment used	.33	.26	.34	.34	.31	.25	.33	.12	.27
Administrative Expense—Physics Share	.20	.10	.25	.05	.15	.11	.18	.06	.12
Direct Expense Physics Department	.55	.72	.49	.41	.53	.32	.44	.41	.48
The interest is divided in four parts as follows: On Lands held for the Common Good	.06	.03	.21	.01		.01	.01	.01	
On Buildings held for the Common Good	.08	.05	.05	.01	.05	.01	.10	.02	
On Physics Building and the Land on which it stands	.17	.12	.07	.28	.24	.18	.18	.07	
On Physics Equipment	.02	.06	.01	.05	.02	.05	.04	.02	
The direct expense is divided in four parts as follows: Educational Salaries Expense	.40	.47	.36	.26	.32	.15	.27	.26	.30
Laboratory Attendant Expense	.02	.09	.01	.02	.05	.03	.02	.03	.04
Equipment and Supplies Expense	.05	.11	.04	.06	.05	.06	.08	.06	.07
Maintenance and Operation of Building Expense	.08	.05	.08	.07	.11	.08	.07	.06	.07
TOTAL NUMBER OF STUDENT-HOURS IN PHYSICS	83,235	65,730	4,950	82,740	85,320	90,270	13,040	81,150	506,435

TABLES 9 AND 10

By means of these two tables, I have suggested a system of reports which can be published either in the treasurer's annual report or in the catalogue, and which I believe will give those who are responsible for the administration of an institution of higher education the data by means of which they can compare the work done in the various teaching departments as well as the cost of maintaining these departments. Inasmuch as these data can be obtained without any increase in the accounting force, and practically without any additional expense, it seems likely that at one or more institutions it may be found possible to institute immediately such a system of reports. In order to help in such an undertaking, I have arranged these reports so as to make it easy to reproduce them in a printed page. The amount of matter, in each case, is that which will conveniently go on the ordinary six by nine page. In order to make it possible to get up such a set of reports in the exact form in which they might be published by a college or university, I have originated a fictitious institution of higher education, called the Smith Technological Institute; and I have considered as the several departments of this institution the departments of physics at the eight institutions visited, as follows:

Columbia	*Physics Department*
Harvard	*Chemistry Department*
Haverford	*Biology Department*
Massachusetts Institute of Technology	*Astronomy Department*
Princeton	*Mathematics Department*
Toronto	*Geology Department*
Williams	*Botany Department*
Wisconsin	*Economics Department*

The eight pages constituting Tables 9 and 10 must then be considered as sample pages taken from the catalogue or the annual report of the treasurer of the Smith Technological Institute.

Table 9 is an analysis of the teaching in each of the eight departments of this institute. On this table are shown all the courses given, with the data covering each. On Table 10 are given a summary of the teaching of each of the departments; a summary of the teaching of the institution; a summary of the expenses of each department; and a summary of the expenses of the institution as a whole. The teaching in the various departments is contrasted with the expenses on the third page of Table 10, and the expense per student-hour shown, and these expenses per student-hour analyzed.

Dr. Eliot recently gave the number of courses offered at Harvard as about four hundred. It would require not more than ten or twelve pages in the Treasurer's Report of Harvard University to give the same kind of data about each of these four

hundred courses, and the expenses of operating each of the departments, as we have given for the fictitious Smith Technological Institute. Most other institutions, of course, could give this information in much less space.

There are always certain basic statistics and other data which it is necessary to have about an industry or other line of effort before one can even begin to speculate intelligently as to the character and efficiency of its organization and the work it is doing. With such statistics and data given, it is often easier for an outsider to suggest points of strength and of weakness than it is for those more intimately associated. This is one of the large elements of strength in publicity.

In preparing the reports which appear on Tables 9 and 10, I have tried to include the statistics and data which seem to me most essential to a study of any given institution of this class and of the class itself. It is practically impossible now to obtain this from college catalogues or treasurers' reports. To get this information by the methods which we have been forced to use in making this study involves unwarranted demands upon the time of men otherwise fully engaged. If information of this kind is to be secured at such large effort, it is not likely to be secured with enough regularity to make it of any great use. The records and books of the schools themselves should be so maintained as to give it as regularly as they now give the total number of students, courses of instruction, or the cash balance.

SAMPLE PAGES FROM THE ANNUAL REPORT OF THE SMITH TECHNOLOGICAL INSTITUTE

AN ANALYSIS OF TEACHING BY DEPARTMENTS

DEPARTMENT	NUMBER OF COURSE[1]	NAME OF COURSE	NUMBER OF WEEKS GIVEN	HOURS PER WEEK FOR A SINGLE STUDENT			NUMBER OF GROUPS OR SECTIONS INTO WHICH CLASS IS DIVIDED FOR TEACHING PURPOSES			NUMBER OF STUDENTS REGISTERED TO TAKE THE COURSE			THE FIGURES IN THESE COLUMNS ARE GIVEN IN TERMS OF STUDENT-HOURS															
													The students taking the course are recruited from the various classes as follows:					The courses are rated in difficulty or pedagogical sequence as follows:				In form of exercise the courses are divided as follows:			The courses are elective or prescribed as follows:			TOTALS
				Laboratory	Lecture	Recitation	Laboratory	Lecture	Recitation	For the first term only	For the second term only	For the whole year	First year	Second year	Third year	Fourth year	Graduates	Elementary	Medium	Graduate	Research	Laboratory	Lecture	Recitation	Absolutely required	Required to do something else	Free choice	
Physics	P 3	*Elem. Mech. and Genl. Phys.*	15		2	3		2	10	234			15075	1125	1200	150		17550					7020	10530	14625		2925	17550
The figures given under the Physics Department are actually a record of the teaching in the Department of Physics at Columbia University	P 4	*Genl. Physics*	15		2	1		2	10		203		8000	475	525	135		9135					6090	3845	[2]8000		[2]1135	9135
	M 109	*Theory of Alternatives*	15		3			1		30					90	1215	45		1350				1350		[2]810		[2]540	1350
	M 116	*Theory of Var. Alternatives*	15		2			1			28				60	750	30		840				840		[2]420		[2]420	840
	M 101	*Anal. Mech.*	15		3			2		112					4225	315			5040				5040			4770	270	5040
	M 102	*Anal. Mech.*	15		5			3			113		300	6600	975	600			8475				8475			7950	525	8475
	M 213	*Thermo-Dyn.*	15		2			1		5							150			150			150				150	150
	M 205	*Elec. and Mag.*	15		2			1		9							270			270			270				270	270
	M 206	*Elec. Circuits*	15		4			1			14						840			840			840				840	840
	P 9	*Genl. Physics*	15		2	1		1	4	93			2115	1125	540	405		4185					2790	1395			4185	4185
	P 10	*Genl. Physics*	15		3			1			28		630	270	45	315		1260					840	420			1260	1260
	M 107	*Elec. and Mag.*	15		2			1		22			30	60	540	30			660				660				660	660
	M 108	*Theory Elec. and Mag.*	15		3			1			24				945		135		1080				1080			945	135	1080
	M 1	*Elem. Mech.*	15		2			1		18			120	150	120	150		540					540				540	540
	M 2	*Elem. Mech.*	15		2			1			18		120	150	120	150		540					540				540	540
	M 7	*Thermo-Dyn.*	15		2			1		4					60	60			120				120				120	120
	M 203	*Theory of Potential Func.*	15		2			1		9							270			270			270				270	270
	M 209	*Adv. Theory of Light*	15		2			1		5							150			150			150				150	150
	M 210	*Theory of Light*	15		2			1			4						120			120			120				120	120
	M 201	*Adv. Mech.*	15		2			1		11							330			330			330				330	330
	P 101	*Elec. and Mag.*	15		3			1		10					45	45	360		450				450				450	450
	P 102	*Sound*	15		3			1			8					90	270		360				360				360	360
	P 105	*Elec. Meas.*	15		2			1		14				420					420				420				420	420
	P 103	*Light*	15		3			1		8					360				360				360				360	360
	P 207	*Elem. Theo. Phys.*	15		1			1		4							60			60			60				60	60
	P 208	*Fund. Phenom.*	15		1			1			4						60			60			60				60	60
	Jour. Club	*Journal Club*	30			1½			1			20					900			900				900				900	900
	M 211	*Radiation*	15		2			1		9							270			270			270				270	270
	M 212	*Partial Diff. Eq. of Physics*	15		2			1			9						270			270			270				270	270

[1] These courses should be listed in numerical order.

[2] Approximations.

Table 9

(Continued on pages 108, 109 and 110)

Physics [cont.]	P 201	*Discharge of Elec. The. Gases*	15		2			1		7							210			210			210					210	210
See note on previous page	P 211	*Radiation*	15		2			1		9							270			270			270					270	270
	M 106	*Thermo-Dyn.*	15		2			1			34		30		960	30			1020				1020			1020		1020
	M 2-1	*Elem. Mech.*	15		3			1			13				585			585					585			450	135	585
	A 2	*Elem. Physics*	15	2½	2	1	1	1	5		65		5355					5355				2430	1950	975			5355	5355
	P 212	*Radiation*	15		2			1			9					7	270			270			270					270	270
	S. C.	*Stereo. Chem.*	15		1			1			8				120				120				120					120	120
	M 202	*Theory of Elas.*	15		2			1			11						330			330			330					330	330
	M 6	*Anal. Mech.*	15		3			1			4			135	45			180					180					180	180
	P 41	*Elem. Lab.*	15	3			1			14			630					630				630						630	630
	P 42	*Elem. Lab.*	15	3			1				14		630					630				630						630	630
	P 43	*Intermed. Lab.*	15	3			1			106				4770					4770			4770						4770	4770
	P 44	*Intermed. Lab.*	15	3			1			106	106			4770					4770			4770						4770	4770
	P 61	*Intermed. Lab.*	15	3			1			4					90	90			180			180						180	180
	P 62	*Intermed. Lab.*	15	3			1				4				90	90			180			180						180	180
	P 151	*Adv. Lab.*	15	3			1			14						120	720		840			840						840	840
	P 152	*Adv. Lab.*	15	3			1				14					120	720		840			840						840	840
	P 271	*Res. Lab.*	15	15			1			12							2850				2850	2850						2850	2850
	P 272	*Res. Lab.*	15	15			1				12						2850				2850	2850						2850	2850
	P 206	*Radio Activity*	15		2			1			10						300			300			300					300	300
		Totals		56½	87	6½	11	43	30	763	757	20	34035	20050	11240	4860	13050	40590	31875	15070	5700	20970	45000	17265	23855	15135	44245	83235
Chemistry	B		15	2	1	1	2	1	4	18		57	6286	350	582	698	814	8730				4500	2250	1980			8730	8730
The figures given under Chemistry are actually a record of the teaching in the Department of Physics at Harvard University	C		30	4	1	1	7	1	7			180	16480	9180	3780	720	3240	32400				21600	5400	5400			32400	32400
	2		30	6	2		2	1				9				827	1033		1860			1320	540				1860	1860
	3		30	3½	2		3	1				24		2400	2400	1500	900		7200			5040	2160				7200	7200
	4		30	4	1		3					14			720	1080	720		2520			1680	840				2520	2520
	5		30		3			1				10				450	450		900				900				900	900
	6 *a*		15		3			1		10				45	180	45	180		450				450				450	450
	6 *b*		15		3			1			11				45	45	405		495				495				495	495
	7		15		1			1		2						15	15			30			30				30	30
	9		30		3			1				7					615			615			615				615	615
	11		15		3			1		18				270	270	180	90	810					810				810	810
	12		15		3			1		11				225		180	90		495				495				495	495
	14		15		3			1			14			405	225	90	90		810				810				810	810
	15		15		3			1		7						135	180	315					315				315	315
	17		15		3			1			36			585	495	180	360		1620				1620				1620	1620
	20 *a*		30	24			1					1					720				720	720					720	720
	20 *b*		30	24			1					1					720				720	720					720	720
	20 *d*		30	72			1					3					2160				2160	2160					2160	2160
	20 *h*		30	24			1					1					720				720	720					720	720

SAMPLE PAGES FROM THE ANNUAL REPORT OF THE SMITH TECHNOLOGICAL INSTITUTE

AN ANALYSIS OF TEACHING BY DEPARTMENTS

DEPARTMENT	NUMBER OF COURSE[1]	NAME OF COURSE	NUMBER OF WEEKS GIVEN	HOURS PER WEEK FOR A SINGLE STUDENT			NUMBER OF GROUPS OR SECTIONS INTO WHICH CLASS IS DIVIDED FOR TEACHING PURPOSES			NUMBER OF STUDENTS REGISTERED TO TAKE THE COURSE			THE FIGURES IN THESE COLUMNS ARE GIVEN IN TERMS OF STUDENT-HOURS															
													The students taking the course are recruited from the various classes as follows:					The courses are rated in difficulty or pedagogical sequence as follows:				In form of exercise the courses are divided as follows:			The courses are elective or prescribed as follows:				
				Laboratory	Lecture	Recitation	Laboratory	Lecture	Recitation	For the first term only	For the second term only	For the whole year	First year	Second year	Third year	Fourth year	Graduates	Elementary	Medium	Graduate	Research	Laboratory	Lecture	Recitation	Absolutely required	Required to do something else	Free choice	TOTALS
Physics	P 3	*Elem. Mech. and Genl. Phys.*	15		2	3		2	10	234			15075	1125	1200	150		17550					7020	10530	14625		2925	17750
The figures given under the Physics Department are actually a record of the teaching in the Department of Physics at Columbia University	P 4	*Genl. Physics*	15		2	1		2	10		203		8000	475	525	135		9135					6090	3845	[2]8000		[2]1135	9135
	M 109	*Theory of Alternatives*	15		3			1		30					90	1215	45		1350				1350		[2]810		[2]540	1350
	M 116	*Theory of Var. Alternatives*	15		2			1			28				60	750	30		840				840		[2]420		[2]420	840
	M 101	*Anal. Mech.*	15		3			2		112					4225	315			5040				5040			4770	270	5040
	M 102	*Anal. Mech.*	15		5			3			113		300	6600	975	600			8475				8475			7950	525	8475
	M 213	*Thermo-Dyn.*	15		2			1		5							150			150			150				150	150
	M 205	*Elec. and Mag.*	15		2			1		9							270			270			270				270	270
	M 206	*Elec. Circuits*	15		4			1			14						840			840			840				840	840
	P 9	*Genl. Physics*	15		2	1		1	4	93			2115	1125	540	405		4185					2790	1395			4185	4185
	P 10	*Genl. Physics*	15		3			1			28		630	270	45	315		1260					840	420			1260	1260
	M 107	*Elec. and Mag.*	15		2			1		22			30	60	540	30			660				660				660	660
	M 108	*Theory Elec. and Mag.*	15		3			1			24				945		135		1080				1080			945	135	1080
	M 1	*Elem. Mech.*	15		2			1		18			120	150	120	150		540					540				540	540
	M 2	*Elem. Mech.*	15		2			1			18		120	150	120	150		540					540				540	540
	M 7	*Thermo-Dyn.*	15		2			1		4					60	60			120				120				120	120
	M 203	*Theory of Potential Func.*	15		2			1		9							270			270			270				270	270
	M 209	*Adv. Theory of Light*	15		2			1		5							150			150			150				150	150
	M 210	*Theory of Light*	15		2			1			4						120			120			120				120	120
	M 201	*Adv. Mech.*	15		2			1		11							330			330			330				330	330
	P 101	*Elec. and Mag.*	15		3			1		10					45	45	360		450				450				450	450
	P 102	*Sound*	15		3			1			8					90	270		360				360				360	360
	P 105	*Elec. Meas.*	15		2			1		14				420					420				420				420	420
	P 103	*Light*	15		3			1		8					360				360				360				360	360
	P 207	*Elem. Theo. Phys.*	15		1			1		4							60			60			60				60	60
	P 208	*Fund. Phenom.*	15		1			1			4						60			60			60				60	60
	Jour. Club	*Journal Club*	30			1½			1			20					900			900				900				900	900
	M 211	*Radiation*	15		2			1		9							270			270			270				270	270
	M 212	*Partial Diff. Eq. of Physics*	15		2			1			9						270			270			270				270	270

[1] These courses should be listed in numerical order.

[2] Approximations.

Table 9

(Continued on pages 108, 109 and 110)

Physics [cont.] *See note on previous page*	P 201	*Discharge of Elec. The. Gases*	15		2			1		7							210			210			210				210	210
	P 211	*Radiation*	15		2			1		9							270			270			270				270	270
	M 106	*Thermo-Dyn.*	15		2			1			34		30		960	30			1020				1020			1020		1020
	M 2-1	*Elem. Mech.*	15		3			1			13				585			585					585			450	135	585
	A 2	*Elem. Physics*	15	2½	2	1	1	1	5		65		5355					5355				2430	1950	975			5355	5355
	P 212	*Radiation*	15		2			1			9					7	270			270			270				270	270
	S. C.	*Stereo. Chem.*	15		1			1			8				120				120				120				120	120
	M 202	*Theory of Elas.*	15		2			1			11						330			330			330				330	330
	M 6	*Anal. Mech.*	15		3			1			4			135	45			180					180				180	180
	P 41	*Elem. Lab.*	15	3			1			14			630					630				630					630	630
	P 42	*Elem. Lab.*	15	3			1				14		630					630				630					630	630
	P 43	*Intermed. Lab.*	15	3			1			106				4770					4770			4770					4770	4770
	P 44	*Intermed. Lab.*	15	3			1			106	106			4770					4770			4770					4770	4770
	P 61	*Intermed. Lab.*	15	3			1			4					90	90			180			180					180	180
	P 62	*Intermed. Lab.*	15	3			1				4				90	90			180			180					180	180
	P 151	*Adv. Lab.*	15	3			1			14						120	720		840			840					840	840
	P 152	*Adv. Lab.*	15	3			1				14					120	720		840			840					840	840
	P 271	*Res. Lab.*	15	15			1			12							2850				2850	2850					2850	2850
	P 272	*Res. Lab.*	15	15			1				12						2850				2850	2850					2850	2850
	P 206	*Radio Activity*	15		2			1			10						300			300			300				300	300
		Totals		56½	87	6½	11	43	30	763	757	20	34035	20050	11240	4860	13050	40590	31875	15070	5700	20970	45000	17265	23855	15135	44245	83235
Chemistry *The figures given under Chemistry are actually a record of the teaching in the Department of Physics at Harvard University*	B		15	2	1	1	2	1	4	18		57	6286	350	582	698	814	8730				4500	2250	1980			8730	8730
	C		30	4	1	1	7	1	7			180	15480	9180	3780	720	3240	32400				21600	5400	5400			32400	32400
	2		30	6	2		2	1				9				827	1033		1860			1320	540				1860	1860
	3		30	3½	2		3	1				24		2400	2400	1500	900		7200			5040	2160				7200	7200
	4		30	4	1		3					14			720	1080	720		2520			1680	840				2520	2520
	5		30		3			1				10				450	450		900				900				900	900
	6 *a*		15		3			1		10				45	180	45	180		450				450				450	450
	6 *b*		15		3			1			11				45	45	405		495				495				495	495
	7		15		1			1		2						15	15			30			30				30	30
	9		30		3			1				7					615			615			615				615	615
	11		15		3			1		18				270	270	180	90	810					810				810	810
	12		15		3			1		11				225		180	90		495				495				495	495
	14		15		3			1			14			405	225	90	90		810				810				810	810
	15		15		3			1		7						135	180	315					315				315	315
	17		15		3			1			36			585	495	180	360		1620				1620				1620	1620
	20 *a*		30	24			1					1					720				720	720					720	720
	20 *b*		30	24			1					1					720				720	720					720	720
	20 *d*		30	72			1					3					2160				2160	2160					2160	2160
	20 *h*		30	24			1					1					720				720	720					720	720

Table 9 (Concluded)

See note on preceding page	16	*Theory Optics*	30		2			1				6				360			360				360					360
	6	*Acoustics*	15		1			1			130			1200	750			1950				1950		1770		180	1950
	20	*Thermo-Dyn.*	15		3			1		3						120			120				120					120
	19	*Acoustics*	15		1			1			3					60			60				60					60
	22	*Hydro-Dyn.*	15		1			1			12						180		180				180				180	180
		Elec. Mag. Theo.	30		1½			1				12					540			540			540				540	540
	23	*Colloidal Sol.*	15		1			1		12							180			180			180				180	180
		Totals		30	44½		27	24	1	318	385	1374	47370	30780	6660	4050	1410	81270	6450	1470	1080	46050	43830	390	83730		6540	90270
Botany	I		15	2	3		6	2		88			1275	3600	1275	450		6600				3466	3134				6600	6600
Figures under Botany are from Physics Dept. at Williams College	II		15	6	2						38		1126	1689	564	901		4280				2472	1808		.		4280	4280
	III		30	4	2							13	120	120	960	360			1560			975	585				1560	1560
	IV		15	2	2					5					120	120			300			150	150				300	300
	V		15	4	2						5				120	180			300			150	150				300	300
		Totals		20	11					93	43	13	2521	5409	3039	2071		10880	2160			7213	5827				13040	13040
Economics	1		30	2	4	1	17	1	10			152	9240	13440	7140	2100		31920				9120	18240	4560	9120	18240	4560	31920
The figures given under Economics are actually a record of the teaching in the Department of Physics at the University of Wisconsin	2 *b*		15		3			1			9		65	52	164	99			360				360				360	360
	3 *b*		15	4			1				5		120	60	60	60			300			300					300	300
	4		15	8			1				4					480			480			480					480	480
	5		30	7			2					12		180	720		1620		2520			2520					2520	2520
	8 *b*		15		3			1			5					45	180		225				225				225	225
	9		15			3		1	5	5						225				225				225			225	225
	10		30			1		1				10					300			300				300			300	300
	11		15	7			1			6							630		630			630					630	630
	15		30		3			1				11				90	900			990			990				990	990
	17		30		3			1				3					270			270			270				270	270
	19		15			3			1	11							495			495				495			495	495
	20		30		3			1				5					450			450			450				450	450
	101		30	2	2	2	12	1	12			217	3060	30960	4140	900		39060				13020	13020	13020	38160		900	39060
	104		15	4			3			40				180	2100	120			2400			2400			2400			2400
	105		15	4	1		1	1			7					150	375		525			420	105			525	525
		Totals		38	22	10	38	8	25	62	30	410	12485	44852	14324	4269	5220	70980	7440	2730		28890	33660	18600	49680	18240	13230	81150

TABLE 10

REMARKS covering Table 10 were given in the note preceding Table 9. The source of money used in the departments is of such vital importance that it is suggested that another report uniform with that given on this table be prepared covering it. On such a report, opposite the total expenditures for each department, should be given the amounts which are derived, respectively, (1) from specific endowments, (2) from the general endowments of the institution, and (3) from fees, etc. In the report of the treasurer of Princeton University a very satisfactory model for this statement will be found.

FURTHER SAMPLE PAGES FROM THE ANNUAL REPORT OF THE SMITH TECHNOLOGICAL INSTITUTE

PART 1. SUMMARY OF TEACHING

Department	Number of Courses		Number of Students			Number of Registrations			The Figures in these Columns are given in Terms of Student-Hours															Totals
									The Students taking the courses are recruited from the various classes as follows:					The courses are rated in difficulty or pedagogical sequence as follows:				In form of exercise the courses are divided as follows:			The courses are elective or prescribed as follows:			
	Offered, but not taken	Given	For the first term	For the second term	For the year	For the first term	For the second term	For the year	1st year	2nd year	3rd year	4th year	Grad.	Elem.	Med.	Grad.	Research	Laboratory	Lecture	Recitation	Absolutely required	Required to do something else	Free choice	
Physics [*Columbia*]	3	49	569	586	642	736	757	20	34035	20050	11240	4860	13050	40590	31875	5070	5700	20970	45000	17265	23855	15135	44245	83235
Chemistry [*Harvard*]	4	19			350	37	65	339	21766	13460	8697	6145	15663	42255	16350	645	6480	40620	17730	7380			65730	65730
Biology [*Haverford*]	1	3			30			31	166	3630		1154		4620	330			2340	1770	840	165	1320	3465	4950
Astronomy [*Mass. Tech.*]	19	24	772	524		366	539	728		43110	27000	12630		46965	35775			27900	37065	17775	81240		1500	82740
Mathematics [*Princeton*]	13	27	559	552		625	581	5	40770	27510	8025	3180	5835	65880	10440	3610	5490	40260	34845	10215	65880	2400	17040	85320
Geology [*Toronto*]	4	31			552	318	385	1374	47370	30780	6660	4050	1410	81270	6450	1470	1080	46050	43830	390	83930		6540	90270
Botany [*Williams*]		5	105	55		93	43	13	2521	5409	3039	2071		10880	2160			7213	5827				13040	13040
Economics [*Wisconsin*]	8	16	540	463		62	30	410	12485	44852	14324	4269	5220	70980	7440	2730		28890	33660	18600	49680	18240	13230	81150
Totals for the Smith Technological Institute as a whole	52	174	2545	2180	1574	2264	2400	2920	169112	188801	78985	28359	41178	363440	110820	13425	18750	214243	219827	72465	304550	37095	164790	506435

PART 2. SUMMARY OF EXPENSES

DEPARTMENT	THESE VARIOUS CLASSES OF EXPENSES MAY BE CONSOLIDATED OR FURTHER SUBDIVIDED AS MAY BE THOUGHT DESIRABLE[1]								
	Administration Expense		Direct Salary Expense		Equipment. This of course will be only that part of expenditures for equipment which is considered as expense	Supplies	Maintenance and Operation of Quarters occupied		Totals. In this col. will be found the whole exp. of the institution divided between the teaching depts.
	General. Included in this is each dept.'s share in expenses of adm. the institution as a whole. These charges are pro-rated	Special. These are departmental adm. expenses or those which can be charged direct without pro-rating	For teaching. This item might be subdivided to show amount paid each grade	Salaries other than teaching such as mechanicians and laboratory attendants			General. In this column will be put all items incl. in the unit of floor space rate	Special. These are special repairs, etc., which are peculiarly chargeable to a given dept.	
Physics [*Columbia*]	16799.64		33600.00	2100.00		4223.18	6203.69		62926.51
Chemistry [*Harvard*]	6527.18		30925.00	5789.00		7206.58	3335.58		53783.84
Biology [*Haverford*]	1243.10		1800.00	50.00		200.00	405.85		3698.95
Astronomy [*Mass. Tech.*]	4483.83		21350.00	2066.00		5319.82	5795.18		39014.83
Mathematics [*Princeton*]	12384.58		27200.00	3860.00		4550.00	9700.00		57694.58
Geology [*Toronto*]	10317.17		13850.00	2380.00		5883.03	6811.10		39241.30
Botany [*Williams*]	2381.44		3500.00	250.00		1000.00	993.50		8124.94
Economics [*Wisconsin*]	5600.00		21525.00	2294.82		5000.00	4637.02		39056.84
Total Expenses for the Smith Technological Institute as a whole	59736.94		153750.00	18790.32		33382.61	37881.92		303541.79

[1] A column should be reserved for research or some means taken to keep research expenses separate. Just what method should be used will depend upon how the relation between research and teaching is interpreted. Research may be considered a departmental over-head expense.

Table 10 (Continued on page 114)

Table 10
(Concluded)

PART 3. TEACHING AND EXPENSE CONTRASTED

ANNUAL REPORT

DEPARTMENT	TOTAL		Total Expense per Student-Hour	These various subdivisions of the total expense per student-hour will correspond to the division of accounts on preceding page							
	Student-Hours	Expense		Adm. exp. general	Adm. exp. special	Salary exp. teaching	Salary exp. attendance, etc.	Equipment exp.	Supplies exp.	Main. and op. of building exp. general	Main. and op. of building exp. special
Physics [*Columbia*]	83235	62926.51	.75	.20		.40	.02		.05	.08	
Chemistry [*Harvard*]	65730	53783.84	.82	.10		.47	.09		.11	.05	
Biology [*Haverford*]	4950	3698.95	.74	.25		.36	.01		.04	.08	
Astronomy [*Mass. Tech.*]	82740	39014.83	.46	.05		.26	.02		.06	.07	
Mathematics [*Princeton*]	85320	57694.58	.68	.15		.32	.05		.05	.11	
Geology [*Toronto*]	90270	39241.30	.43	.11		.15	.03		.06	.08	
Botany [*Williams*]	13040	8124.94	.62	.18		.27	.02		.08	.07	
Economics [*Wisconsin*]	81150	39056.84	.47	.06		.26	.03		.06	.06	
	506435	303541.79	.60								

TABLE 11

This shows the average number of students in the different kinds of exercises (laboratory, lectures, and recitations) in elementary and medium grade work. The tabulation is restricted to these grades, because at all the institutions the size of sections in graduate and research work is small and largely the result of chance.

There seems to be the widest difference of opinion as to what constitutes a proper size for a class. If we had weighted these sections in proportion to the number of times a week they meet, this difference would probably have been even more marked. I was informed at one place that it was practically impossible to lecture to more than one hundred and twenty-five students in physics, yet our table shows that at four institutions there are classes of more than one hundred and fifty students. This question of size of sections is so largely pedagogical that the figures are submitted without further comment and for what they may be worth.

Table 11

SIZE OF LABORATORY, LECTURE AND RECITATION SECTIONS

Number of Students engaged in the Exercises scheduled	Character of Exercise																											
	Laboratory									Lectures									Recitations									
	Columbia	*Harvard*	*Haverford*	*Mass. Inst. Technology*	*Princeton*	*Toronto*	*Williams*	*Wisconsin*	Totals	*Columbia*	*Harvard*	*Haverford*	*Mass. Inst. Technology*	*Princeton*	*Toronto*	*Williams*	*Wisconsin*	Totals	*Columbia*	*Harvard*	*Haverford*	*Mass. Inst. Technology*	*Princeton*	*Toronto*	*Williams*	*Wisconsin*	Totals
5 (or less) students		5	1			2	1		9	1		1			3			5				2					2
6 to 10 students		3		1	5			6	15	2	4		1	1	1			9				1					1
11 to 15 students	4		1	21			7	22	55	1	1	1		1	4	1		9			1					22	23
16 to 20 students		7	1	2					10	1	1	1		2				5		11	1						12
21 to 25 students					10				10	1	1			1	1			4	14			13	13				40
26 to 40 students		2				1			3	1	1							2				3					3
41 to 70 students						18			18	2		2						4									
71 to 150 students	1					1			2	3	1		3	5	1			13									
Over 150 students											1		2		3		2	8									

APPENDIX

EXHIBIT A

SAMPLE OF EMPLOYMENT BULLETIN

THE following employment bulletin is issued monthly by The American Society of Mechanical Engineers and is referred to in the body of the report, page 28:

EMPLOYMENT BULLETIN

THE Society has always considered it a special obligation and pleasant duty to be the medium of securing better positions for its members. The Secretary gives this his personal attention and is most anxious to receive requests both for positions and for men available. Notices are not repeated except upon special request. Copy for notices in this Bulletin should be received before the 15th of the month. The list of men available is made up of members of the Society, and these are on file, with the names of other good men, not members of the Society, who are capable of filling responsible positions. Information will be sent upon application.

POSITIONS AVAILABLE

067 Manager for factory located at Newark-on-Trent, England.

068 Instructor in mechanical and architectural drawing, for Tuesday and Thursday evenings, October to May. Location, Queens Borough, City of New York. Experience in teaching and tact required. Familiarity with manufacturing, drafting-room methods essential.

069 Selling engineer wanted for steam condensers. Location, Philadelphia.

070 Wanted, ambitious young man, with selling experience, to represent in Chicago a company manufacturing transmission machinery.

071 Wanted, a young technical graduate, with good scholastic record and at least two years' practical experience, for position of assistant in laboratory of engineering school; salary $1000 for academic year. Location, Massachusetts.

072 Man experienced in general machinery; to work on board and handle six men under general instruction of chief engineer; experience absolutely essential on jig-work and general design. Further, experience in transmission, conveying, gears, etc., preferred; good opportunity for live, capable man; give full details of experience, salary expected, and positions previously held, naming employers in first letter; all information held strictly confidential; immediate opening; location, Ohio.

MEN AVAILABLE

254 Member, with fifteen years' experience, an expert on gas engines, gas producers, gas furnaces, gasoline and oil engines, pumping machinery of every description, air compressors, blowing engines, rolling mills, etc., both designer and superintendent, desires change. Now chief engineer of medium-size shop; would prefer larger concern or one willing to take up these branches anew. University graduate, best of references.

255 Manual training and university technical graduate; age 33, thirteen years' practical experience in machine shop, drafting, designing, testing, estimating, etc.; has employed and had charge of men; desires position, preferably in Philadelphia or vicinity. Would consider an opportunity in the commercial line of engineering or manufacturing.

256 Representative of gas power company, desirous of entering into correspondence with a few firms in the machine line in the United States interested in the development of trade in Europe, Asia and Africa, with view to forming arrangements to represent them.

257 Chief draftsman and designer of special machinery for manufacturing firm. Five years' experience power plant construction, irrigation and general engineering. At present, gas and mechanical engineer for corporation. Executive ability. Position as superintendent of maintenance or construction or as mechanical engineer with contracting or consulting firm.

258 Associate, age 29, technical graduate, two years' experience general drafting, four years of teaching and research in the field of the gas producer, gas engine and steam boiler, capable of directing and handling both mechanical and chemical sides of this line of work, desires position as professor or assistant professor of experimental engineering or as testing engineer in charge of experimental work for a manufacturing plant.

259 Member, long experience in pumping machinery, air compressors, Corliss engines, condensing apparatus; desires position as chief engineer or chief draftsman near New York.

260 Assistant engineer, age 29, Cornell University, M. E., executive and designing ability and good business judgment, ability as investigator and organizer. Broad general experience in mechanical and civil engineering on railroad and car work, steam boilers, gas engines, industrial plant equipment, power house, hydro-electric work, special designs; seeks position as works manager or engineer in moderate-sized progressive concern.

261 Affiliate and associate member Am. Soc. C. E., eight years' experience on design and construction in steel and reinforced concrete, especially familiar with power-houses and structures for street railway and lighting companies; open for engagement, June first.

262 Junior member, graduate mechanical engineer, seeks position which will offer a future. Three and a half years' general experience as draftsman, steam engineering and special work. Present salary $125 per month.

263 Assisting manager at present engaged with company operating blast furnaces, mines, etc.; technical education, familiar with manufacture of merchant pig iron, including Gayley Dry Blast, and all details entering into plant operation; can handle men and produce results.

EXHIBIT B

EXTRACTS FROM THE REPORT OF THE TREASURER OF HARVARD UNIVERSITY FOR YEAR 1907–08

THE matter on this page and the two which follow it is quoted from the Report of the Treasurer of Harvard University for the year 1907–08. These quotations constitute the *only* references in the Treasurer's Report to either the Jefferson Physical Laboratory, the department of physics or physics itself. The interest of these excerpts for the purposes of this study is explained on pages 60 to 62 in the body of this report. From this point the matter is quoted:

INCOME AND CURRENT EXPENSES FOR DEPARTMENTS [*From p. 12*

GENERAL ITEMS ONLY

THESE tables show for each department the receipts available for salaries, retiring allowances and general expenses, the amount of such expenses, and the resulting surplus, or deficit. They are summaries of only these general items in the more comprehensive and detailed tables beginning on page 89.

JEFFERSON PHYSICAL LABORATORY [*From p. 20*

(See Table No. XVIII, page 151)

AVAILABLE FOR EXPENSES

Income of funds and balance	$3,881.78	
Sale	87.00	$3,968.78
Amount available for expenses		$3,968.78

PAYMENTS [*From p. 21*

General expenses	$3,687.58	
University charge	238.99	
	$3,926.57	
Less the amount which was paid from College income (see Table II, page 117)	766.23	3,160.34
Surplus		$808.44
In 1906–7 there was a deficit of	$ 67.77	
The Jefferson Physical Laboratory credit balance on July 31, 1908, was	$2,675.20	

[FROM TABLE INCOME AND EXPENSE]

JEFFERSON PHYSICAL LABORATORY, as per Table XVIII (page 152) [*From p. 49*

Expenses of research, paid from Funds and gift	$3,155.98	
Other expenses	3,687.58	
	$6,843.56	
University charge	238.99	
	$7,082.55	
Less amount paid from College income (see Table II, page 117)	766.23	$6,316.32

From p. 89

RECEIPTS AND PAYMENTS FOR DEPARTMENTS

THE following tables are intended to show in detail the resources and expenditures of each department of the university. The receipts include every gift and the income of every fund. The payments include every payment for the specific object of every gift and fund. The items are stated separately except in the case of payments for a general object such as salaries, in which case the payments are merged under the general heading. These tables are not found in the treasurer's books, but are a transcript from the books and form a balanced statement, as shown on page 162.

From p. 151

TABLE NO. XVIII

JEFFERSON PHYSICAL LABORATORY

RECEIPTS

Income of Funds			
JEFFERSON Physical Laboratory balance (interest on)		$ 94.28	
Physical Laboratory Endowment		3,787.50	
JOSEPH LOVERING		421.62	
T. JEFFERSON COOLIDGE, for Research in Physics			
Loans to be used in place of income			
Loan	$2,500.00		
Interest	57.01	2,557.01	
Anonymous Gift for Physical Research, interest		28.79	$6,889.20
			$6,889.20
From p. 152 Gifts for the salary of a Fellow for Research in Physics			
Gifts		$2,000.00	
Interest		23.73	2,023.73
Sale of old steam engine			87.00
			$8,999.93

PAYMENTS

Research in Physics, from			
T. JEFFERSON COOLIDGE Fund		$2,403.26	
JOSEPH LOVERING FUND		326.51	
Anonymous Gift for Physical Research		426.21	$3,155.98
Printing		$ 212.16	
Repairs		166.23	
Care and cleaning		1,078.00	
Fuel		477.94	
Water		53.64	
Lighting		259.50	
Telephone		72.89	
Insurance		132.45	
Services and wages		848.00	
Electric power		380.96	
Supplies and sundries		5.81	
		$3,687.58	

Less the following, paid from College income (see Table II, page 117)			
Repairs	$166.23		
Fuel, services, etc.	600.00	$766.23	$2,921.35
			$6,077.33
University charge (see p. 89)			
Treasurer's Office, care of investments		$83.60	
Bursar's Office, collections and payments		19.72	
Watchmen		85.50	
Publication Office, salary and expenses		50.17	238.99
			$6,316.32

BALANCED SUMMARY OF THE TABLES

[*From p. 162*

Table	Receipts	Payments
I. University	$ 85,726.58	$ 61,552.60
II. College	1,412,149.85	1,059,717.38
III. Library	67,339.19	82,865.53
IV. Divinity School	44,334.26	44,304.73
V. Law School	142,140.88	120,174.83
VI. Medical School	273,339.28	230,527.46
VII. Dental School	52,775.71	21,645.65
VIII. Bussey Institution	27,895.56	20,128.78
IX. Arnold Arboretum	31,424.43	34,718.18
X. Botanic Garden and Botanical Museum	9,924.52	9,285.25
XI. Gray Herbarium	153,610.32	12,660.57
XII. Observatory	59,230.93	63,461.38
XIII. Museum of Comparative Zoölogy	42,446.12	40,860.20
XIV. Peabody Museum of American Archaeology and Ethnology	19,860.08	18,364.01
XV. Semitic Museum	1,439.23	13,289.71
XVI. Germanic Museum	1,885.62	1,428.15
XVII. William Hayes Fogg Art Museum	6,322.02	5,875.08
XVIII. Jefferson Physical Laboratory	8,999.93	6,316.32
XIX. Appleton Chapel	2,577.22	2,577.22
XX. Phillips Brooks House	1,784.52	1,705.04
XXI. Hemenway Gymnasium	2,218.00	2,218.00
XXII. Stillman Infirmary	23,884.05	24,014.67
XXIII. Sundry Funds for Special Purposes	46,646.66	22,808.60
XXIV. Construction Accounts	36,340.12	215,859.61
XXV. Sundry Accounts	632,656.00	691,995.63
	$3,186,951.08	$2,808,354.58

Total amount of payments		$2,808,354.58
Total amount of receipts	$3,186,951.08	
Less gifts for capital account	449,822.53	2,737,128.55
Balance, which is the net decrease of funds and balances, excluding gifts for capital, as is shown also on page 11		$71,226.03

EXHIBIT C

SCHEDULE AND INSTRUCTIONS FOR FILLING OUT

THE data in regard to the disposition of the time of the teaching staff were secured largely by requesting each teacher of physics to fill out the schedule shown on page 126. The instructions for filling these out read as follows:

INSTRUCTION ON FILLING OUT SCHEDULE

AT least one schedule is sought from every person who has any teaching to do in the field covered by the department of physics. Those who make out schedules are requested to make them out in full, *i.e.*, to cover the entire week, even if the time devoted to physics is only a small proportion of the whole time given to the university. When the schedule is the same for each of the terms in the college year 1908–09 only one schedule is desired. Where the schedule is different during two, three or four terms there should be two, three or four schedules. Kindly mark the schedule in place provided showing term to which it belongs. If more than two schedules are required, it will be necessary to use two sheets. Each person making out a schedule will kindly place at the top (*a*) his name, (*b*) title of chair or other post he fills, and (*c*) a memorandum of any special duties he may have not suggested by his title, which may be useful in interpreting the schedule.

Kindly first fill in in black ink all absolute appointments under the following heads. (Where the period used does not run full hours please note it.)

A. LECTURE

B. PREPARATION (for lectures). Put down under this head only such time as may be given regularly to this purpose at the same hour and same place each week.

C. RECITATION (quiz, section, conferences, etc.). Put under this head those hours usually devoted to recitation purposes, but which may be from time to time varied with some lecturing.

D. LABORATORY

E. CONSULTATION. This is to cover advertised office hours regularly kept for the purpose of private consultations, principally with students.

F. MEETINGS (faculty meetings, etc.).

G. RESEARCH (personal). Only put entries under this head when the schedule is followed with approximately the same regularity as under the other heads.

In every case where any of the above entries are made the number or other designation of the lecture room, study, etc., should be given, also the course. Entries under the foregoing head will only be made where the same hour each week is regularly devoted to the same purpose. The coöperation of those making out schedules is specially requested in the care with which the foregoing entries are made. Unless a high degree of accuracy is aimed at, the comparison will lose much of its value.

The foregoing is intended to include that part of the productive time which is disposed of in virtually the same way each week. Of what remains there is a certain amount which in a way follows some schedule. For instance, on Friday between two and four, Mr. Roe usually gets time for personal research or study; or between nine and ten on Tuesday

Mr. Doe runs over a lecture which he is to deliver that morning at eleven. Please write such entries in a different way from the others, preferably in red ink (pencil will answer, or if in black ink put a ring around them).

In general, kindly make entries as full as possible. In case it is desired to explain anything, use an asterisk and put on back of schedule sheet.

SCHEDULE OF.....

TITLE.....

.....

		MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
.....TERM	8.00						
	9.00						
	10.00						
	11.00						
	12.00						
	1.00						
	2.00						
	3.00						
	4.00						
	5.00						
.....TERM	8.00						
	9.00						
	10.00						
	11.00						
	12.00						
	1.00						
	2.00						
	3.00						
	4.00						
	5.00						

EXHIBIT D

SECTION SCHEDULE AND INSTRUCTIONS FOR FILLING OUT

THE data in regard to the size of sections, number of student-hours, etc., were secured largely by requesting those in charge of the various departments of physics to fill out the following section schedule. The instructions covering this work read as follows:

INSTRUCTIONS ON MAKING OUT SECTION SCHEDULE

USE one line on the section schedule for every different section. A section will be considered to be those students who are taught or quizzed on the same subject, during the same period, by the same teacher with or without assistants. Thus a class studying the same subject, but divided into three parts and taught at perhaps the same hour in different rooms by different teachers, will be considered three sections. Thus wherever there is a change in (*a*) the students who are taught, (*b*) the hour, (*c*) the place, (*d*) the teacher, or (*e*) the subject, a new section is created.

The letters used below in giving directions for filling in the section schedule are those at the heads of the various columns of the schedule.

Please begin with the first period Monday morning and give all the sections taught in this period, one line to each section. Then give those sections taught in the second period. Thus go consecutively through Monday. Then begin with the first period on Tuesday and go consecutively through Tuesday. Thus go consecutively through the week. Where the section schedule changes with the term, make it out complete for each term.

A. Under this column simply give a serial number so that the last serial number will represent the number of sections for the term, or for the year if the terms are alike.

B. Fill in the initial of the day of the week in which the section is taught. As the sections are grouped by days, this letter need not be repeated.

C. Under the subject give the descriptive title such as "Physics," "Sound," "Light," and follow this with the designating letters, figures, or other symbol so that the course can be identified in the printed or other lists of courses offered. In the column headed "Grade" put a letter to indicate the degree of difficulty of the course as follows:

E Elementary
M Medium
G Graduate
R Research

The elementary grade will cover branches taught ordinarily in the freshman or sophomore year, or which are taught during the first year or two of study of a subject. Medium will include branches taught in the junior or senior year and which it is ordinarily assumed have already been taken by a graduate continuing in physics. Graduate branches will be those that are rarely taught except to graduate students. Research courses will be those in which after the subject has been chosen the student is not required to follow any set series of exercises.

D. Give the hours at which the section convenes.

E. Give the number or other designation of the room, hall or laboratory where the section meets.

F. Under the period give the name of the person in charge of the section as well as the names of his assistants. The names of assistants would include helpers outside the teaching staff. The effort will be made through this information to figure the cost of recitations, laboratory work and lectures.

G. Divide the students in any section into first, second, third and fourth year men and graduates. Then total them.

H. State how long the period is in hours.

J. There will be an entry in only one of the three columns under J, in any one line. Thus, if it is a laboratory section with twenty students, and lasting three hours, the entry will be *sixty, i.e.,* sixty student-laboratory-hours.

K. Under this column put only the time regularly spent in preparation, only the time taken every week at the same hour. When this time is regularly devoted to the work, of course it becomes a part of the expense of giving the lectures to which it belongs. Give not only the name of the lecturer, but his assistants.

L. An effort will be made to determine the proportion of student-hours undertaken by the students from free choice and those which are undertaken because of prescription, more or less binding.

M. Please do not write under this column.

N. Use the remarks column to make clear any of the entries. Please add any exercise in physics left over after all the sections have been listed if there are any such.

A	B	C			D	E	F		G						H	J			K		L			M			N
		Subject					Period		Students							Student-hours			Preparation for teaching req.		Number of students taking course because						
									Year																		
Serial number	Day of week	Title	Course	Grade	Hour of day	Room	In charge of	Assisted by	1st	2nd	3rd	4th	Grad.	Total number	Hours in period	Laboratory	Lecture	Recit., Conf., Quiz, etc.	By	Hours	Abs. required	Required to do something else	Free choice				Remarks

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